The Science Teacher

Dry Falls in the Grand Coulee of Washington (See page 8).

In this issue —

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The Science Teacher

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The Importance of Insects in War Times

C. L. METCALF*

University of Illinois | Urbana, Illinois

With this issue we are introducing a series of six timely articles on the "Importance of Insects in War Times" of which this is the first installment. These articles are of particular interest in high school biology as well as to teachers of zoology and entomology in college. The complete series is written by Professor C. L. Metcalf, head of the department of entomology of the University of Illinois, a recognized national authority in his field. He is well known as a co-author on "Destructive and Useful Insects." —Editor.

ALL who have studied the matter carefully recognize that insects are mankind's greatest enemies, even in peace times. In the stressful times of war the insects become vastly more important and grave competitors for our very existence on earth.

Unfortunately there is a very widespread lack of adequate information and appreciation of the tremendous conflict that these tiny, inconspicuous, quiet and insidious, six-legged pests are continuously waging against us; and also of the many efficient methods that have been discovered and perfected by entomologists, by which the damage may be prevented or greatly reduced. Too often biology is defined, and thought to consist of only zoology and botany; sometimes physiology and bacteriology are also mentioned, but rarely is entomology given proper emphasis. For example, it is incredible and inexcusable that the medical and premedical curricula of most colleges and universities do not include courses in medical entomology and insect control, although a number of hours of zoology are generally required. I think this is due to the fact that those who have established the premedical curricula have assumed that the study of insects would be covered in zoology courses and have not realized that in most of the leading American universities entomology is a separate department from zoology; and so the premedical students get no adequate training concerning the most important group of animals there is — the insects. Although some zoologists attempt to cover the subject of entomology in their general zoology courses, the science of entomology is so vast and intricate that only a student who has specialized in it and devoted years to the study of insects and the enormous volume of literature dealing with them, can be competent to teach the subject.

MANY high school graduates apparently do not know what entomology is. Teachers of biology and general science should realize that entomology, the study of the largest and most destructive group of animals on earth—the Class Hexapoda including three times as many species and at least a half-million times as many individuals as there are of all other terrestrial animals combined—has come to be a science as distinct from zoology as bacteriology is from botany, and the most important biological science from the economic standpoint. Biology teachers should also appreciate that every important principle can be adequately and emphatically illustrated from the lives of insects. Phases of insect control are often discussed in courses in horticulture, agronomy and animal pathology; but, again, it should be realized that the subject is so complicated and important that only one who devotes his entire lifetime to entomology will be able to present the subject in an up-to-date and efficient manner.

* Professor C. L. Metcalf is head of the department of entomology of the University of Illinois.

IN discussing insect-borne diseases, such as bubonic plague, many writers refer to rats as the carriers but say nothing about fleas, without which plague would rarely attack man and would really be an asset to man in killing the pestiferous rats. And, in discussing malaria, writers often emphasize the importance of quinine and other preventive or remedial medicines, but say nothing about the destruction of the mosquito carriers, which is a much safer, more effective and permanent method of control.

In at least five of our war-time efforts the insects are probably the greatest obstacles to our success. As a group, insects eat everything of an organic mature: all living plants, all living animals, and all products derived from plants or animals.

First, in connection with the program for increased food production. A vast army of insects demand as food the very things which we must have for nutrition: our grains, fruits, vegetables, nuts, meats, cheese, candies, even tobacco and drugs of nearly every kind. Anyone who has ever tried to grow field crops, vegetables or fruits knows that constant fighting is required to prevent insects from destroying the crops. The greater the concentration and the larger the acreage of crops, the better is the opportunity for the growing and increase in numbers of insects, and the greater their damage is certain to be, unless we are more alert to control and prevent their devastation than ever before. If, as seems certain, increased food production will be a vital factor in winning the war, then redoubled efforts on the part of all crop producers and greater vigilance than ever before to anticipate and prevent insect outbreaks, make the work of trained entomologists a "critical occupation." If insects are effectively controlled, a greater increase in production will probably result than from any other single effort. Victory gardens and other efforts to increase production are likely to be only disappointing, wasteful exertions, unless as much emphasis and as careful attention are given to controlling the *negative* factors of production—insects and plant diseases—as to the better understood *positive* factors, such as selection of the best varieties, proper planting, fertilizing and cultivating. Since entomologists have discovered and developed effective control measures for practically every known pest, a very important war effort at the present time is to have men in the military service adequately trained in entomology and to get the most up-to-date information about insects to our armed forces, to men on the farm fronts, to those in food-processing factories and storage plants, and to housekeepers and others engaged in feeding and housing both our martial forces and civilians.

THE *second* war effort to which insects stand opposed with tremendous power is the production of essential plant fibres, wool and hides; and the health, efficiency and productive capacity of all domestic animals, whether grown as a source of meat and eggs, as a source of leather and wool, or as beasts of burden.

Thirdly, we must not only *produce*, we must also *protect* all kinds of stored foods and feeds; fibers; the structural timbers of wooden buildings; tool- and implement-handles, wood for gun stocks and other war materiel; paper stocks and records; and all other kinds of organic stored supplies. Protecting harvested, stored and processed materials is as essential as adequate production and their greatest hazard is insects' attacks.

Fourthly, and most important of all, is the protection of our military and civilian personnel from annoyance, reduction of efficiency, illness and death that results from the diversified and devastating attacks of thousands of kinds of insects, mites and ticks and the deadly diseases they disseminate. An enormous horde of these pests insists upon having the fresh warm blood of man, of our domestic animals or of fowls, as their only acceptable food. It is the securing of food that results in most of the two or three billion dollars worth of damage that the bugs cause every year in the United States, alone. The annoyance that our troops in encampments and on army maneuvers have already suffered on this continent from mosquitoes, chiggers, bed bugs, fleas, lice, ants and cockroaches is important, but slight, compared to the suffering they will be subjected to in tropical and subtropical Africa, in the Pacific islands, Australia, China, India and Malay.

IN the *fifth* place, we must safeguard America, the Beautiful, from grave menaces to our future welfare by the introduction of new pests which have not previously gained a foothold on this continent. Other parts of the world are teeming with many serious insects of crops, pests of man and animals, and disease-carrying insects which we have never yet had to fight. Our Federal Bureau of Entomology and Plant Quarantine is constantly on the alert to intercept such pests in all kinds of foreign shipments. In one seven-year period over 3,100 such infested shipments, containing over 400 different kinds of insect pests, were intercepted and destroyed at our ports of entry. Efficient as this service has been since 1914, at present it is likely to be greatly hampered by the shortage of trained inspectors, due to the draft; by the increased importation of products and air- and water-traffic with other continents; by the fact that the arrival time of freight vessels cannot now be announced so that inspectors may be on hand when the ships dock; by disabled foreign vessels coming to our ports, often laden with products that in normal times are prohibited entry to this country because of the new insect pests they are likely to contain; and by the practice of bringing garbage from ships into ports and dumping it there, so as not to give enemy submarines a clue as to the location of the ships.

A *sixth* phase of the importance of insects in war times is the grave threat of entomological or biological warfare; that is, the intentional spread by our enemies of destructive insect vectors of human- animal- and crop-diseases. The Japanese have already attempted to start epidemics of bubonic plague at several places in China. They apparently did not achieve much success because, from lack of entomological appreciation, they merely scattered the bacilli of plague about on food particles, instead of scattering living, active, infected flea carriers of the plague. As the allies have warned the Axis, if they use poison gas we shall retaliate with the same weapons, so it seems to me we should provide men well trained in medical and veterinary entomology and the technique of rearing and handling living insects, not only as a defense against entomological warfare, but also as a possible offensive use of this terrible but incomparable method of destroying our enemies The possibilities of such warfare are extremely potent. By distributing crop pests, especially ones not present in our enemies' territories, far and wide from low-flying airplanes, upon their growing crops, it would be possible to destroy a large part of their food supplies—not only the crops growing at that time, but also plantings of successive years. Pests of stored foods and other stored products could be showered over cities, food depots, etc., in mild weather with almost certain assurance of devastation. Most effective of all would be the purposeful spreading of infected insect carriers of highly fatal human diseases. Terrible as is the thought of such action, if we must kill our enemies to restore peace to the world, I do not see that it is any more sinful to kill them with diseases than with bombs or bullets. Such warfare would be like scattering bombs that would not only kill at the time, but would live, spread and multiply a thousand-fold or more in succeeding years. There is certainly no other method of warfare that would enable us to destroy so many of our enemies, with danger to so few of our own men. The release of a few hundred thousand human lice or "cooties" infected with the germs of tyhus fever, among enemy troops, might well wipe out 75 or 80 per cent of them in a few months' time. Rats infested with fleas and infected with bubonic plague could be released in a besieged fortress, city or island and would probably provide a conflagration of disease and death vastly more devastating than any raid of bombing planes, landing of parachute troops, bombardment with long-range guns, or even the use of poison gases. The release of some infected yellow-fever mosquitoes in areas where that disease has never prevailed, although the mosquito vectors are established there, as in the Oriental islands occupied by our enemies and in Japan, would almost certainly start epidemics of most far-reaching importance to the allies. Naturally we would not consider the use of this terrible method of warfare, if our enemies had not already shown that they have no

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Editorial and News

The Physicist to the Fore

If this war has done nothing else to our educational system, it has emphasized the importance of physics in the curriculum. There is a pressing need for men who understand even the elementary principles of physics and there are few such men available. The army needs them, the mechanics of modern war is based on the principles of physics. Industry also needs them.

And just why are trained men in the field of physics so scarce? To answer that question we must know why so few have taken physics in the high school, the place where training in this area should begin. Now that the war training program is upon us we can see what everyone should have seen all the time, that it is the teaching of physics in terms of definite, practical, and challenging objectives that counts. The requirements of war training, as now being met in the schools, effectively demonstrate this point. We trust it is driven home so that authors and publishers, curriculum workers and teachers will make the future physics course have more point and meaning in terms of student and adult life needs and be planned in terms of common experiences of the learner. Then physics enrollment will show the increase it deserves. But the chemsitry and biology teacher must not lose sight of the important work *they* perform. People trained in these areas are also needed now as well as in the time of peace to follow. At present the work of the chemist is not so evident from the demands that come back from the front. But they are vital to the production front which is tremendously essential to the successful prosecution of the war. And after the war the demand of industry will be even greater in this field.

The important point to remember, however, in regard to science in the curriculum on all levels, is that it must be functional. Then it will grow in its usefulness in our educational system.

AMERICAN COUNCIL TO MEET IN INDIANAPOLIS

A three day meeting of the *American Council of Science Teachers* is now being planned June 25-29, to be held in Indianapolis, Indiana, in conjunction with the meeting of the National Education Association. This has been announced by Dr. Philip Johnson of Cornell University, president of the association. As now planned there will be sectional meetings for elementary science, the biological sciences and the physical sciences in addition to a regular general meeting. Leaders in the various fields of science will be invited to participate on the program. Science teachers should plan now to attend.

March Meeting Cancelled

The American Council will not be able to carry out its plans for a joint meeting with the N. A. R. S. T. on March 1st because of the cancelling of the St. Louis Convention of the American Association of School Administrators and all allied organizations scheduled for that date. This change is announced by Norman R. D. Jones, vice-president of north central area and convention chairman for the American Council.

OUR FRONTISPIECE

For our frontispiece we are indebted to S. A. Chester of Bloomington High School, Bloomington, Illinois. The picture is of Dry Falls in Grand Coulee of Washington. During the last glacial epoch a torrent of water eight to ten times the volume of the Mississippi fell over this great cataract. Note the several layers of the lava plateau, indicating several periods of volcanic activity.

Suggested Emphasis in the Physical Science

RAY C. SOLIDAY*

Chemical Warfare Service **Chicago, Illinois**

THIS is a particularly pleasant experience to me for two reasons; first, because it permits the renewal of friendships, many of which have originated in these conferences, and secondly because this is the first time I have been able to offer advice to science teachers without being subject to questioning about my own success in such procedures.

It must be emphasized that what I say here today can be considered only as my own personal opinions, without approval or consent of the War Department. No one else knows what I am going to say or has approved a manuscript.

These suggestions are offered for your considerations with full knowledge that they will not all be applicable to your local situations, and that many of you are already doing the things which I propose.

First, I offer three rather general suggestions. One, be assured that your job in your particular community is more important than any other contribution you might be making in some other capacity, in the armed services or otherwist. I personally believe this is true in nearly every case. Your sincere realization of htat fact, and your earnest effort to make that statement true, is of tremendous importance.

THE second general suggestion is that you do everything you possibly can to make the physical sciences more valuable in their actual service to the local community. Tie your teaching and outside activities as closely as possible to the local interests and activities of the community. Use your science teaching as a contribution to the success of such community enterprises as the production and storage of food, rubber conservation, salvage programs for scrap metal, tin, etc., thus stimulating interest of your students in these community problems and at the same time teaching science.

Third, refuse to be limited by subject material barriers. Teach the facts and ideas which you consider most valuable, regardless of your particular subject assignment. This is not exactly a radical recommendation. There has been a considerable tendency in this direction for several years. In this connection I think particularly of the possibilities and desireabilities of teaching practical mathematics in physics and chemistry courses. I think of teaching health in chemistry and general sciences. I think of teaching aeronautics and meteorology in physics. I think of developing ability in expression in all of the science courses.

NOW for some more specific suggestions: First, put all the emphasis you can upon the geographical aspects of your science. This is simple in chemistry. Emphasize the geography of raw chemical resources and of the distribution of chemical products. Use maps as much as you can. There seems to me to be no reason whatever why history and Latin teachers should have their rooms plastered with maps and the science teachers seldom if ever use maps. Encourage your students to collect maps, particularly to show trade routes of importance in the mining, refining and use of these chemical materials. Give particular emphasis to the geography of chemical materials in Alaska, Russia, and China, as related to world trade and especially to your own community.

FOR those of you teaching physics and general science, give serious consideration to the possibility of developing, as a real community service, a weather forecasting project in your school, either as a classroom activity or a club project. If an organized project of this type does not seem feasible, give emphasis to the most successful methods of forecasting the weather in individual homes thru use of comparatively inexpensive and simple

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* Captain, Chemical Warfare Service, United States, and former president of the Illinois Association of Chemistry Teachers. The speech here given was presented at a luncheon meeting of the association at Urbana, Illinois, November 6, 1942.

The Determination of the Vitamins

I. Microbiological Method

J. B. SHIELDS

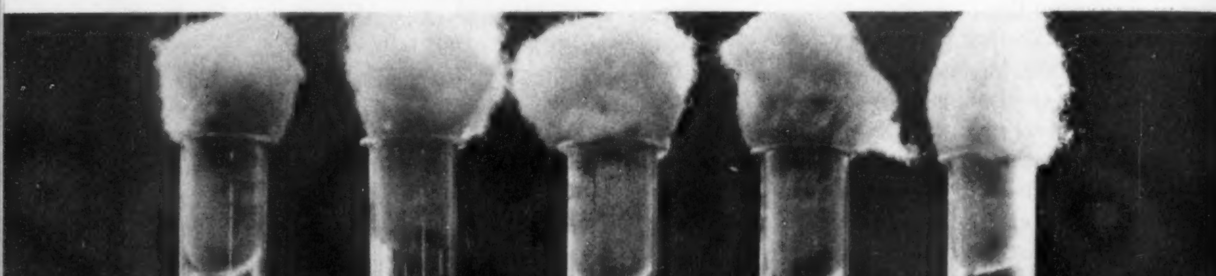
University of Illinois **Urbana, Illinois**

The most recent microbiological methods in vitamin determination are here presented by Professor Shields. In succeeding issues he will deal with chemical and biological methods of determination. —Editor.

CERTAIN branches of science become popular subjects for investigators when some discovery opens a fresh field. It may result in a completely new branch of science such as bacteriology following Pasteur's discoveries. Again, it may be a new tool of research that provides the impetus. Examples of this are the microscope, microbalances, X-ray, and at present, the cyclotron.

Vitamin investigations have been limited in scope because of inadequate methods of analysis. As a little boy said, "If you don't know what you had, how do you know where it went." That statement becomes more pertinent when one realizes how important it is to trace accurately the behavior of vitamins in the body. Such seemingly simple but important investigations as measuring human requirements are only approximations without an accurate method of analysis. It might be well to add that even with a good method, it is still a very difficult matter to determine the human requirements for any vitamin. There are tables available but they are opinions of experts based on the best information available and will certainly be revised as more accurate data are obtained.

ANALYTICAL methods may be a prosaic topic to discuss but their importance is keenly appreciated by the investigator who



STANDARD TUBES FOR A RIBOFLAVIN ASSAY

has tried to increase our fund of knowledge with poor methods. Several years ago, one prominent scientist stated that there was more work being done on vitamin C than on all the other vitamins put together. The reason for this was that there was a fairly reliable chemical method for this vitamin.

At the present time there are three different methods used for vitamin determinations. The oldest is that of the animal assay in which growth or some other criterion is used. A diet containing all the nutrients except the one in question is prepared and the behavior of a group of animals on this diet supplemented with some of the unknown material is compared with that of a similar group of animals eating the same diet supplemented with a known amount of the pure vitamin. This method is slow, expensive, and requires very rigid control to be accurate. The second method is that of chemical analysis and depends on a chemical or physical property of the material which enables us to distinguish it from other materials. The property of fluorescing when a solution is placed in a beam of light from a mercury lamp is an example. We now have pure crystalline vitamins and the increased chemical knowledge of their properties has been a foundation stone for the development of methods of analysis. The third method is the subject of this discussion and is generally called the microbiological method.

THE name "microbiological" really explains the basis of the method. Microorganisms are used instead of animals. A media is prepared containing all known food factors needed by the microorganism *except* the vitamin to be determined. After a definite length of time their rate of growth is determined and compared with that of a standard curve.

Sounds simple, doesn't it? The advantages are obvious. Here you have millions of organisms instead of a dozen rats. Thus the individual variation is ruled out. It is a great time saver, too. Rat growth takes 3 to 6 weeks, the microorganisms require 72 hours.

It might be best to describe the procedure for one of the vitamins as an illustration of the way the method works. Suppose we use lactobacillus casei as the organism for the determination of riboflavin by the method of Snell and Strong.

The media is prepared to furnish all known factors needed by the organisms *except* riboflavin. Since these factors are not accurately known, certain natural materials containing many things are used. Some whole autolyzed yeast has the vitamin removed by treatment with basic lead acetate in alkaline solution. Peptone is the source of protein. It is dissolved in an alkaline solution and placed in direct sunlight for a day or two. Since riboflavin is easily destroyed by light, this procedure is necessary if peptone is to be used as a source of protein. Glucose is used as a source of food energy and sodium acetate is added to buffer the lactic acid produced and maintain the correct acidity for bacterial growth. Small quantities of other inorganic salts and amino acid cystine complete the mixture. The riboflavin is added to this medium lactobacillus casei will grow and produce lactic acid. The amount of growth depends on the amount of riboflavin added until a certain level is reached. This is approximately 0.25 mg. (microgram). One mg. is one-thousandth of a milligram or one-millionth of a gram. That illustrates the extremely small quantities that are being determined.

THE sample is prepared by grinding with sand or homogenizing in some instrument such as a Waring blender. Plant material must have a cell wall ruptured. It is extracted by heating on a steam bath or in an autoclave at 15 lbs. pressure for 15-20 minutes. The extract is filtered and the filtrate diluted so that 1 ml. contains approximately .05 mg. of riboflavin. Aha! You think we must know our answer before we seek it. You are right. The approximate strength of the extract must be known in order to fit the curve.

The extract and media are now adjusted to an acidity of pH 6.6-6.8 and are ready to set up. Five ml. of media is measured into each test tube. Sixteen tubes are used as standards. Exact quantities of riboflavin are added to each ranging from 0 to .5 mg. Each sample requires 10 tubes. Duplicate tubes have 1, 2, 3, 4 and 5 ml. of extract added

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Synthetic Rubber

CHARLES C. PRICE

University of Illinois **Urbana, Illinois**

SINCE December 7, 1941, it is hardly necessary to point out the vital role rubber plays in our modern civilization. The fact that we were using nearly half a million tons of rubber a year during the 1930's is perhaps sufficient indication. It seems to me that the possibility of disrupting both our civilian and military economy by depriving us of this vital strategic material was perhaps an important factor in the Japanese decision to attack the United States and Great Britain. If so, it must be a bitter blow for the Japs to learn that we will be making synthetic rubber at the rate of a million tons a year by 1944. This colossal new industry will thus supply us with synthetic rubber at more than double the rate we used the natural product before the war. Production at this level will represent a thousand fold increase in the short span of five years.

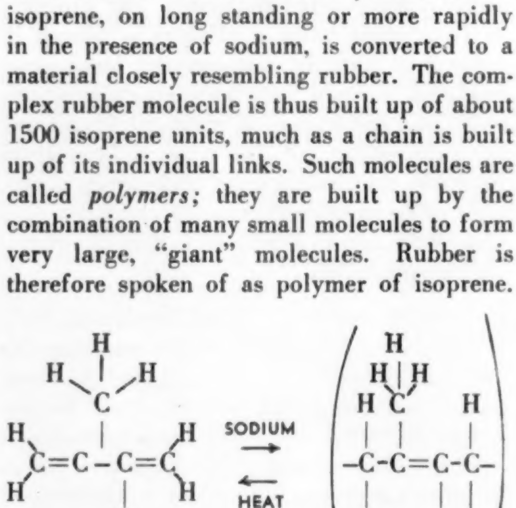
In order to more clearly depict the overall problem of synthetic rubber substitutes, a brief consideration of a few significant facts concerning natural rubber may be helpful.

IN the first place, it is a matter of interest that we were dependent on the Far East for the major portion of our rubber since the rubber tree, *hevea brasiliensis,* is a native of Brazil and the wild jungle trees were the principal, although not the only, source of the world's rubber up to 1910 when rubber sold for over $3.00 a pound. Since then the cultivated plantation trees of the Far East, giving a greater yield of superior rubber, have far outstripped the wild trees of Brazil. In 1913 plantation rubber production passed Brazilian and by 1922, 93.5% of the world supply was plantation rubber and the price was down to 11.5c a pound.

The great importance of rubber depends upon its remarkable physical and chemical properties and it is my purpose to discuss briefly some aspects of the relationship of these properties to the structure of the rubber molecule and to outline the preparation and important properties and uses of some of the synthetic materials which we are using to replace natural rubber.

CHEMICALLY, rubber is a hydrocarbon, i.e., it is composed entirely of atoms of carbon and hydrogen. The most remarkable feature of its structure is the enormous size of the molecule — as molecules go! Each molecule may contain as many as 7500 carbon atoms and 12,000 hydrogen atoms, some 6000 of the carbon atoms being attached to each other in one long chain.

The decomposition of rubber on heating to generate the relatively simple substance, isoprene, the composition of which is the same as that of rubber, indicates that the large rubber molecule is built up of isoprene units. This surmise is substantiated by the fact that isoprene, on long standing or more rapidly in the presence of sodium, is converted to a material closely resembling rubber. The complex rubber molecule is thus built up of about 1500 isoprene units, much as a chain is built up of its individual links. Such molecules are called *polymers;* they are built up by the combination of many small molecules to form very large, "giant" molecules. Rubber is therefore spoken of as polymer of isoprene.



ISOPRENE C_5H_8

RUBBER $(C_5H_8)_{1500}$

This synthesis of rubber was first accomplished in 1882 by Tilden, who prepared isoprene from the heat decomposition of turpentine. We are using this process today to prepare true synthetic rubber on a small scale; the product is superior to other synthetic rubbers in retaining elasticity at extremely low

temperatures. This is an important consideration for such applications as airplane de-icers.

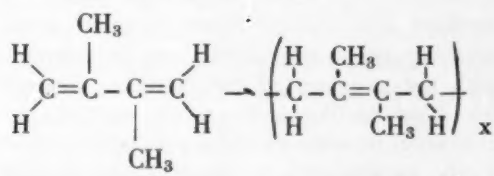
THE search for an explanation of the elasticity of rubber has lead to an immense amount of investigation and speculation. It is now generally believed to be due to the fact that the long chain rubber molecules have a tendency to be coiled like a spring; they will stretch readily under tension but when released the molecules rapidly retract to the original coiled state.

The extremely useful physical properties of rubber might never have become so important had it not been for the presence of the "double bond" in each isoprene unit. This double bond represents a point of chemical reactivity and it was undoubtedly these groups in the rubber molecule which reacted with elementary sulfur when Charles Goodyear accidentally spilled a mixture of these two materials on a hot stove. Much to his amazement the rubber did not become soft and sticky; in this way the process of vulcanization was discovered. The heating of rubber with sulfur, known as vulcanization, overcame rubber's objectionable property of becoming soft and sticky when warm, hard and brittle when cold, and really established the possibility of widespread use of rubber.

IN spite of its many useful properties, however, rubber is not ideally suited for all of its myriad uses. For one thing, the very reactivity so useful for vulcanization, makes rubber subject to deterioration on exposure to air and sunlight or to many strong chemicals. Furthermore, rubber swells and softens in contact with oils, such as gasoline, kerosene, and many other mineral and vegetable oils and greases.

The search for synthetic rubber has therefore not been just a search to synthesize natural rubber but to synthesize a variety of custom-made *substitutes* for natural rubber which may replace rubber in one or more of its many varied uses and which may actually be superior to rubber for these particular uses. The most publicized efforts have been to prepare substitutes satisfactory for making tires, since this use has consumed almost three-fourths of our rubber. In addition, however, the application of substitutes for rubber in electrical insulation, water-proofing, adhesives, paints, hard rubber articles, and many other uses, is an important aspect of the synthetic rubber problem.

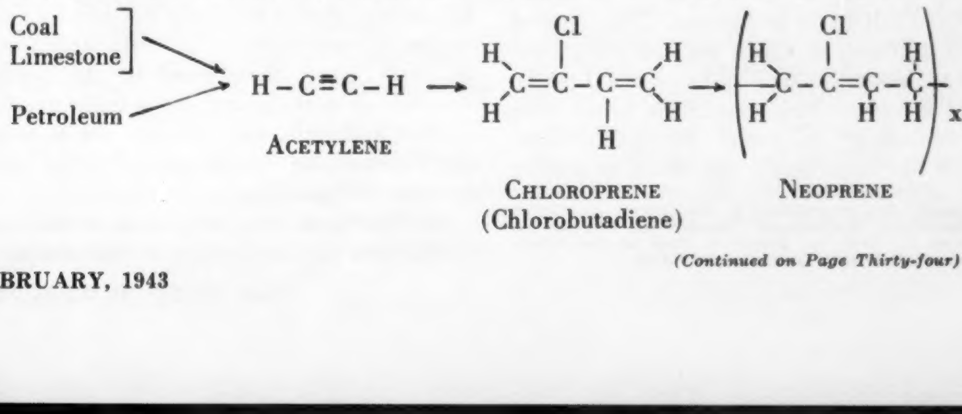
THE first efforts to synthesize a substitute for rubber were spurred by the imminence of the first World War. During the war, Germany made some 2500 tons of "methyl rubber," a synthetic material so named because it differed from rubber in being derived from dimethylbutadiene, which contains one more methyl group than isoprene. It was an inferior product in every respect and was abandoned at the end of the war.



DIMETHYLBUTADIENE METHYL RUBBER

A FAR more successful substitute, *Neoprene*, was prepared by duPont chemists in 1925. This, too, is closely related chemically to natural rubber; the position of the methyl group (CH_3) of each isoprene unit of rubber is occupied by a chlorine atom. Neoprene is prepared by the polymerization of chloroprene.

The product is similar to rubber in appearance and properties but is much more



ACETYLENE

CHLOROPRENE
(Chlorobutadiene)

NEOPRENE

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Applying New Procedures in Teaching Chemistry*

ROBERT L. EBEL

Edison Institute High School **Dearborn, Michigan**

The article by Mr. Ebel is the first of a series intended to further increase the usefulness of the work of the National Science Committee, sponsored by the Division of Science Instruction of the National Education Association. The article deals with the work of the sub-committee on new methods in science teaching and gives an application of its findings in definite situations. Mr. Ebel was chairman of the sub-committee. The application of the work of other sub-committees will be presented in later issues. —Editor.

FOR the past three years it has been my privilege and responsibility to work with the National Committee on Science Teaching. We have been concerned with the development of a program for science teaching. The committee realized from the beginning that no program could be effective if it stopped with a statement of principles and aims. The subcommittee on effective procedures, with which I worked, was given the job of finding or working out specific illustrations of actual teaching procedures which are in harmony with the program of the National Committee. I should like to direct your attention this afternoon to some of those procedures which apply particularly to the teaching of high school chemistry.

The program developed by the National Committee on Science Teaching may be pretty well summed up in the following six points.

(1) Provision for continuous science teaching from kindergarten to junior college. We believe that the tremendous importance of science in the modern world, and of scientific information to the modern citizen justifies this recommendation.

(2) Revision of the content of science courses to meet the life needs of the pupil and the adult he is to become. This implies science teaching in which definite efforts are made to determine the pupil's personal needs, and to determine how science can better serve the community in which the pupil lives. Science has been taught too much as science for the future scientist, and too little as science for the citizen.

(3) Utilization of real life situations and problems in preference to the second hand experiences obtained through text-books in academic classrooms. Notice that the phrase is "in preference to," and not "to the exclusion of."

(4) Utilization of democratic classroom procedures in the teaching of science. This means that the pupils have a part in determining class activities, in controlling pupil participation in those activities, and in evaluating progress. The job of educating the pupil for effective participation in democratic society is one of the responsibilities of science teaching.

(5) Use of the materials and methods of science to deal with controversial topics. Authoritarian opposition to a consideration of the theory of evolution, social morose regarding racial discrimination, and the propaganda of vested interests against consumer science teaching are real problems for the science teacher.

(6) Development of scientific problem solving ability. The committee re-emphasized the importance of the scientific spirit to the individual, and recommends that the student learn, through actual practice, how scientists solve their problems.

THIS, in brief, is the program of the National Committee. Let us make one point very clear. This program is not a royal road to successful science teaching. It is not even a sulfa-drug for the sick science classroom. We believe that it will help the good science teacher to teach better. But it probably would do more harm than good to the teacher who has no real interest in or understanding of boys and girls, and who has not mastered the fundamental techniques of class management and teaching.

As a matter of fact, most of us in this room would have to plead guilty to the charge of

* Prepared for presentation to the Central Association of Science and Mathematics Teachers in Chicago, on November 27, 1942, by Robert L. Ebel of the Edison Institute High School, Dearborn, Michigan.

not teaching as well as we know how to teach. And this, in spite of the fact that we would all admit, if pressed, that we are pretty fair science teachers. What I mean is that we tend to become classroom opportunists, deciding from day to day, even from hour to hour, what lesson we will use in this class or that. Our course outlines, when we are forced to produce one, closely resemble the chapter headings in our textbooks. We find ready-made workbooks a great convenience. We find certain techniques which please us and confine our teaching to the use of these same few day after day, week after week, year after year. Now it is our contention that the common practices we have mentioned above are responsible for a great deal of what is wrong with our science teaching. Here is the argument.

(1) New philosophies and changing points of view in education are not likely to revolutionize teaching techniques. Some new techniques may be developed, most of the old ones will be improved, but if there are science classrooms a hundred years from today, it is rather safe to say that there will be assignments, discussions, demonstrations, laboratory exercises, scientific experiments, projects, etc., in those classrooms.

(2) No single teachnique or logical system of techniques will yield best results in all situations. Effective teaching requires the use of a wide variety of techniques, and the intelligent choice of particular teachniques to fit specific situations.

(3) For the average teacher, greater improvement will result from the study of the individual characteristics and best use of available techniques, than from attempts to develop new procedures.

Having thus disposed of the possible notion that the program of the National Committee on Science Teaching implies a revolution in our classroom procedures, let us turn to the consideration of some illustrations of new procedures of promise in the teaching of chemistry.

THE first new procedure to be described illustrates the use of real life situations and problems in the teaching of chemistry. We are particularly fortunate at the Edison Institute High School in having access to a small but diversified chemical research laboratory. One of the problems which has been under investigation for several years is the economical extraction of magnesium from dolomite. This is, as you know, one of the most critical problems which the war posed for our chemical industry. About six months ago a new experimental magnesium extraction furnace was built just outside the research laboratory. Shortly thereafter we made arrangements for the teaching of this year's course in beginning chemistry for boys in connection with the magnesium research.

There are eight eleventh grade boys in the class. Their first class meetings were given over to instructions in the operation of the furnace. They learned how to prepare the charge, how to load the furnace, how to remove the magnesium, how to clean the furnace, and how to keep the experimental records. In no time at all the boys started to ask questions. These formed the basis for lectures and demonstrations. The explanations required understanding of molecular and atomic theories. Very soon the boys were working with equations, only a few, but those few were mastered. They learned to predict theoretical yields and to calculate percentage yields They learned to look for causes in abnormal variations of yield. Why, for example, should the first "run" in the morning show a consistently higher yield than succeeding "runs"?

NO doubt many of you here would be more interested in a discussion of the actual chemistry of the process than in this description of the teaching procedures. The particulars of the process are still semi-secret, and are of definite military value. I have no wish to risk the wrath of Uncle Sam by talking too much.

This class meets for somewhat less than two hours, four days a week. The instructor in charge is a research chemist (and a bricklayer, steamfitter, welder, or whatever the occasion demands). The boys in the class are an average group, not specially selected for this venture. The mid-semester test covered pretty well the basic chemical skills ordinar-

(Continued on Page Thirty-eight)

Science Clubs at Work

EDITED BY KARL F. OERLEIN

State Teachers College California, Pennsylvania

A department devoted to the recognition of the splendid work being done by the science club members and their sponsors in the various State Junior Academies of Science. Material for this department, such as student made projects; demonstrations and posters; outstanding club programs; state and regional meeting announcements; should be sent to Dr. Oerlein.

In the absence of Dr. Karl Oerlein, who is now serving with the armed forces of the United States, we want you to become acquainted with Dr. Anna A Schnieb, Eastern Teachers College, Richmond, Kentucky. For a number of years Dr. Schnieb has been doing a remarkable piece of work in her state that would be an inspiration to every science teacher. With little in the way of funds she has carried on and has been largely responsible for building a strong and active junior academy in Kentucky. She has consented to edit our club section during Dr. Oerlein's absence. We greatly appreciate this service and believe you will also. We urge you to write her about the plans you are using, things you are doing, projects accomplished, etc. so she can make the club department of the greatest value to all science teachers. — Editor.

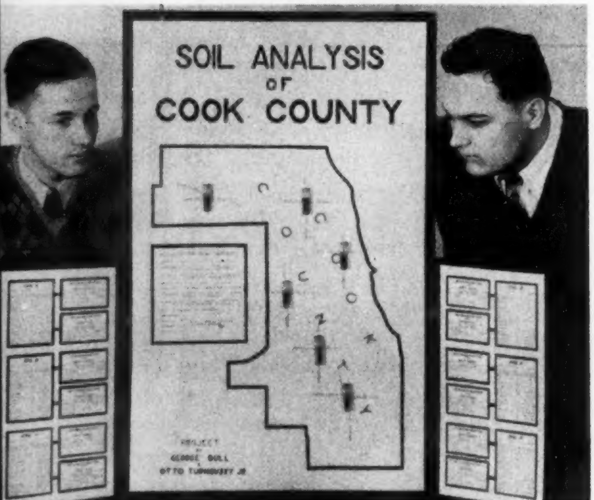
Illinois Junior Academy of Science

MARY CREAGER

Chester High School Chester, Illinois

THE Illinois Junior Academy of Science is meeting the gas rationing situation by a revised program that is being enthusiastically received by science clubs and sponsors. At the fall meeting of the Advisory-Committee in Urbana plans were discussed for a possible substitute for the annual meeting and exhibit of the Junior Academy that has been held at the time of and partly in conjunction with the Illinois State Academy of Science for the past twenty-two years.

Morton High School students analyze soil.



As a result of the meeting and with a one hundred per cent endorsement of the State Academy Council, the following war time set-up is being announced by the general chairman, Mr. Allen R. Moore, J. Sterling Morton H. S., Cicero: The science club or clubs of each school, or two or more schools, if they are near each other, will hold exhibits in the spring to which the school as a whole and the public may be invited. The exhibit may be held in conjunction with a PTA meeting or as an open house meeting during which the affiliated science club or clubs will have charge. Exhibits will be judged on the usual basis, and the Junior Academy certificates of award will be presented. Exhibits will receive first, second, third, or no award depending upon the merits of the work, being judged against a standard rather than against other projects exhibited. In general the plan is to have the superintendent or principal,

the sponsor, and one member of the State Academy of Science act as judges.

Awards will be presented as a school assembly by a Senior Academy member or the superintendent or principal.

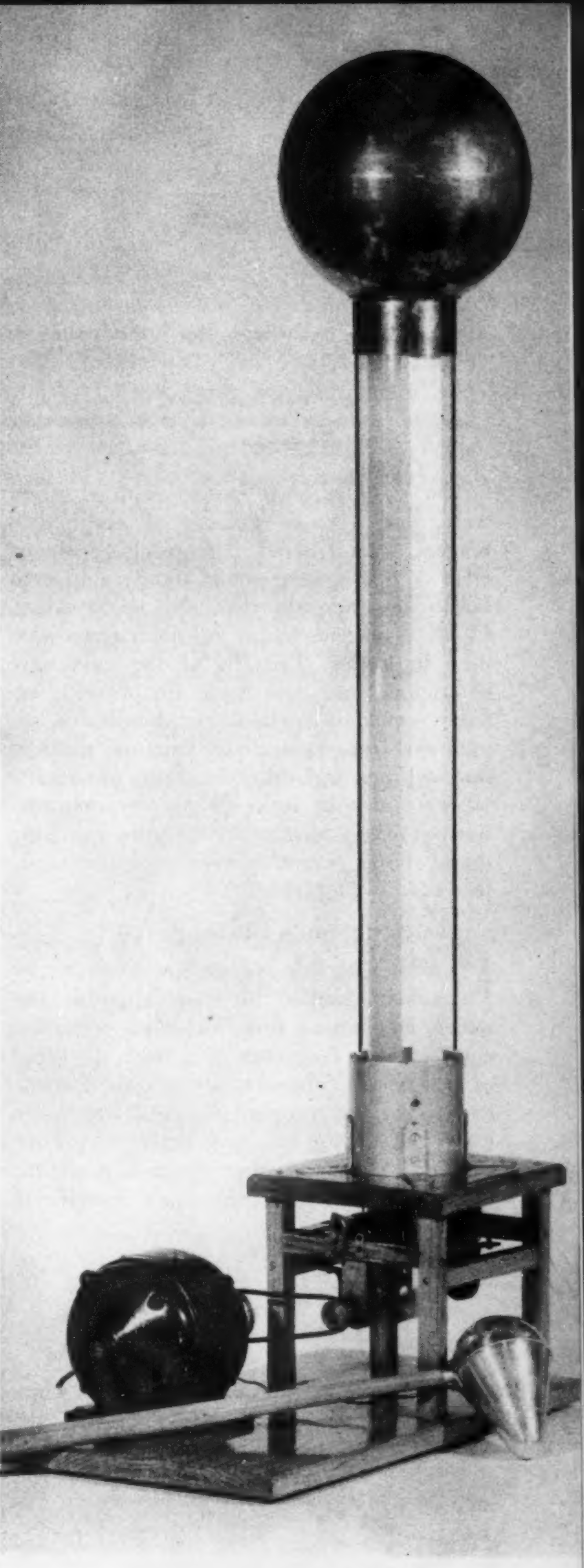
IN Illinois, as in many other states having Junior Academies, the coveted awards are honorary memberships in the A. A. A. S., which are presented each year to the outstanding girl scientist and to the outstanding boy scientist. This includes a membership certificate, a subscription to *Science News Letter*, free registration at the A. A. A. S. National Meeting, and the privilege of attending those meetings that are open to members when that organization meets. This year a new system of selecting these honorary members will be used, and the awards will be made from papers written by the students on their own research, project, or exhibit.

The official publication of the Illinois Junior Academy of Science is *Science Aids Service*. Credit for many years of service is due Mr. Louis A. Astell for his faithful and untiring efforts in editing this publication. Again to Mr. Astell goes credit for the compilation of *Science Aids Service Kits*, which contain from 40 to 110 items and cover such subjects as "Science Clubs and the Junior Academy Movement," "Rubber and Rubber Substitutes," "Plastic, the Miracle Called," etc. These kits furnish materials for club programs and for class work. Junior Academy members obtain the kits on a fifteen-day loan, for transportation charges only.

ONE of the chief aims of the Junior Academy is to encourage students to do independent research, to make scientific investigations, and to construct scientific apparatus. The following reports are of the work of a few of the Illinois Junior Academy members.

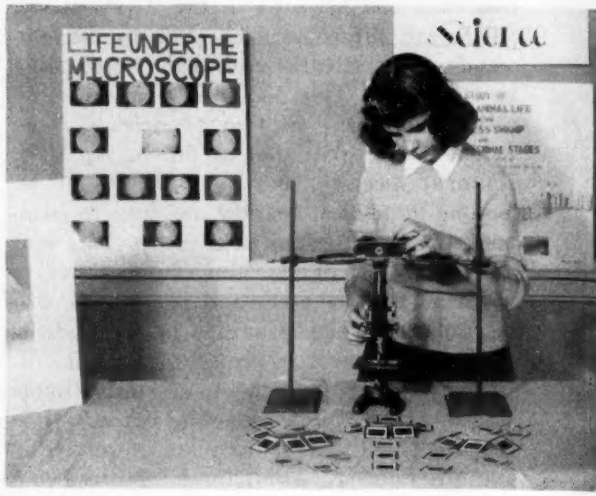
Soil Analysis of Cook County

Otto Turnovsky, my partner, and I selected "Soil Analysis" for our chemistry project and followed the method set forth in our laboratory manual, "Test It Yourself" (Scott, Foresman & Co.). Samples of soil were gathered in the spring from a mixture of soil to a depth of six inches. Collections were made from six scattered locations throughout the county.



Van de Graaff static machine built by Earl Ruesch, Morton High School.

Above: Modeling gives Chester High School students an opportunity to use both artistic and scientific abilities.



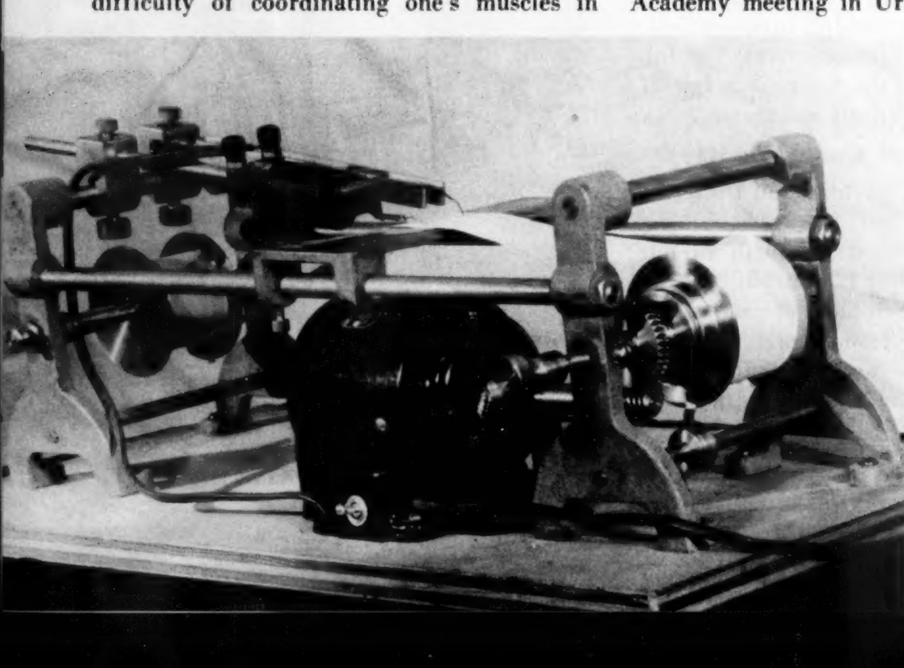
Right: Mary Cecil Craig, Ill. A. A. A. S. honorary member for 1942-2, demonstrating microphotography.

The samples were mixed with distilled water and a small amount of acetic acid reagent, then filtered. The resulting almost clear solutions were put in tightly stoppered bottles, as they absorbed any slight odors. Eighteen reagents and a soil color chart were used in testing. The PH of the soils were determined and tests made for nitrates, nitrites, ammonia, potassium, phosphorus, aluminum, iron, manganese, calcium, magnesium, sulfates, and chlorides. From our results we were able to make proper recommendations as to how to improve the soils, assuming the two crops, creeping bent grass and tomatoes were to be planted.

Morton's Vibrograph

THE object of this project was to devise an improved method for measuring the frequency of a tuning fork. The usual apparatus compared the frequency of a fork, the speed of which was unknown, to an electrical 60-cycle timer and recorded the oscillations upon a piece of moving sensitized paper. The shortcoming of this machine lay mainly in the difficulty of coordinating one's muscles in order to move the paper by turning a crank and plucking the fork at the same time.

(Note: Materials on the above projects were furnished by the following students from J. Sterling Morton H. S., Cicero: "Soil Analysis of Cook County," George Bull; "Experiments in the Building of the Van de Graaff Static Machine," Earl G. Ruesch; "Morton's Vibrograph," Frank R. Holecek; "Climatic Life Zones," Kenneth Gutschick. Each project described received a first place award in its division at the Illinois Jr. Academy meeting in Urbana last spring.)



Monton's Vibrograph — for measuring frequency of a tuning fork.

Climatic Life Zones

KENNETH GUTSCHICK
Student
J. Sterling Morton High School Cicero, Illinois

WHILE assisting my brother in geological field work in north-central Arizona during the summer months of 1941, I became interested in climatic life zones from an exhibit concerning this subject displayed at the Museum of Northern Arizona in Flagstaff. This exhibit showed that six of the seven climatic life zones of the world are present in northern Arizona, from the bottom of the Grand Canyon to the top of the San Francisco Peaks near Flagstaff (a distance of 80 miles). Thus, plants ranging from the desert flora of Mexico to the alpine flora of the Arctic Circle are crowded into a small area. This fact interested me so much that I decided to make a project of climatic life zones in Arizona, with the main part consisting of a collection of diagnostic plants of each zone.

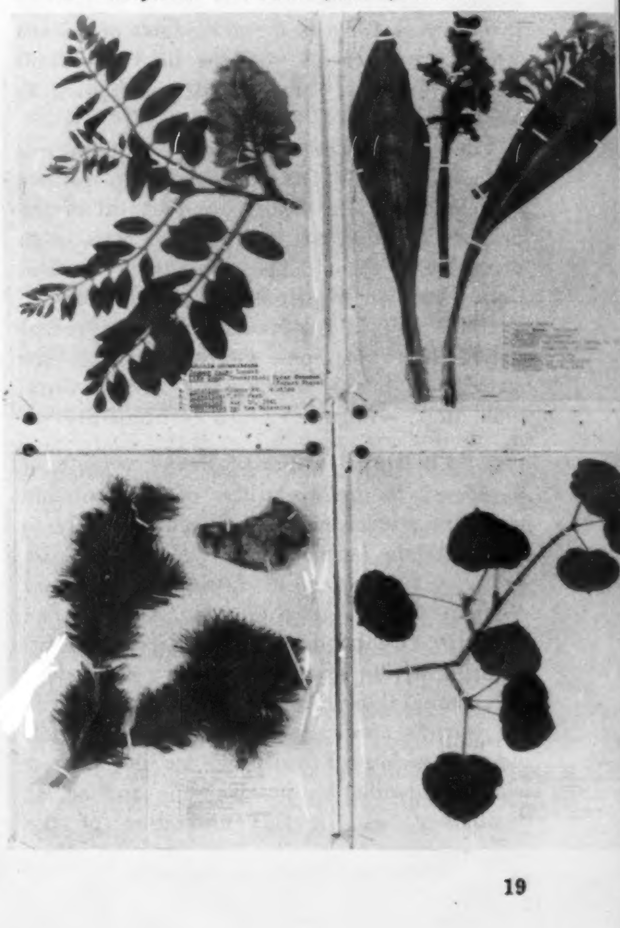
The most interesting part of the project was collecting the plants. Two special trips were made — one to the top of the San Francisco Peaks to collect alpine and sub-alpine plants; the other to the bottom of the Grand Canyon to collect desert and semi-desert flora. This latter collecting trip required special written permission from the Grand Canyon Park ranger-naturalist. I was able to make many other valuable additions to this collection because my brother's field work carried us into many parts of Arizona. By the end of August I had collected about fifty plants, including mesquite, yucca, sage brush, juniper, pinyon, yellow pine, spruce, catchfly, and others. After each collection the plants were pressed and dried between sun-heated blotters.

A VALUABLE part of the project was a group of photographs taken of the various climatic life zones. These pictures enable me to actually see the wide range of vegetation present in Arizona.

The remaining part of the project, which was completed at home, required the most time and labor, since it consisted of mounting the plants and photographs and making poster-illustrations. Each plant was mounted on 8 x 11 white paper, with cardboard used as a base for each sheet, and then covered with cellophane. The poster-drawings consisted of two detailed life zone maps of northern Arizona and North America and two drawings illustrating and explaining the concept of climatic life zones.

Upon the completion of the posters, the project was finished. But my plant collecting is not ended; for if I ever return to the fascinating region of north-central Arizona, I will again go on more interesting collecting trips.

An arrangement of Arizona plant specimens.



Science for Society

EDITED BY JOSEPH SINGERMAN

● A department in which science is presented in its close relationship to the individual and in which guidance is given in causing the individual to recognize the methods of science and its vast social implications.

The Spirit of Franz Boas Lives

FRANZ BOAS will be remembered as a brave soldier in the cause of democracy and human dignity. His guiding spirit and personal example led numerous outstanding scientists and educators to descend from the ivory towers of isolationism, though the cause of social progress is rarely a popular undertaking. Interest in the social implications of science becomes meaningful and effective with concrete activity and application. In his position of leadership, Boas was the guiding spirit in the recent so-called "Boas Committee." The committee did much to lay the groundwork for disseminating facts of science which are essential weapons in our current struggle against the barbarism known as Fascism.

The curernt war situation is stimulating a dramatic interest in the social implications of science. It is a strugle for survival of the decent things we all cherish,—more it is an offensive to expand the frontiers of civilization. Franklin D. Roosevelt and Henry A. Wallace who, a few years ago, paid verbal tribute to Franz Boas, today lead us in the struggle to bring "The Century of the Common Man" within the grasp of humanity.

EVERYBODY is aware of the perversion of science to the brutalities of Fascism and war. But science can be utilized to insure to the world the benefits of *The Right to Work, The Right to Adequate Food, Clothing and Medical Care, The Right to Security, The Right to Education,* and *The Right to Rest.* Insuring a pint of milk for every child does not mean taking food from one portion of the world's population to be spread and divided elsewhere. It will be realized with a widespread advance in economic and social democracy, with a full utilization of the applications of science solely for human well-being, not for individual gain or for the advantage of ambitious groups. This is an appeal which can stir the heart of man, be he "hillbilly" in Kentucky or untouchable in India, be he a miner in Asturia or a machine tender in Helsinky.

Prosecution or the war for freedom to a successful conclusion must of necessity bring with it an overexpanding devotion to the place of science in making freedom a palpable good to man everywhere. To the extent that people in general, and scientists and science teachers in particular, recognize this, will our present sacrifices have been made not in vain.

MUCH is being said and done, in various quarters, about post war planning.. This is an attractive idea. It is a very alluring idea to persons of scientific training. What can be more stimulating to the imagination of the scientist than the proposed blueprinting of a social economic system after the armistice, to assure an orderly readjustment of society to a better peacetime civilization? That is a worthwhile undertaking. But, let me warn you, such speculation has its dangers. It is, unless we are wary, fraught with the possibility of disaster of the first magnitude. This cannot be overemphasized. Suppose you suddenly became aware of a fire in your house. I am sure you would immediately direct all of your attention and energy to getting the fire extinguished. I do not think you would pause to give some thought to the advisability of redecorating your home after the emergency. It would be nice to redecorate the living room and quite interesting to toy with the idea of repainting your home in a new color pattern. If you think this analogy

is far fetched, ask the man on the firing line, the man who knows that any shell may be his last. I venture to guarantee that he is anxious to see the silencing of enemy guns at the earliest possible moment. Once that is accomplished, we shall have his assistance in remodeling our home.

NOW, do not misunderstand me. I am not opposed to post war planning. But, I do insist that each idea be subjected to one test. That is, will it help to hasten the war to a proper conclusion? The industrialist who delays the conversion of his plants to meet pressing war needs and who harasses attempts to break down monopoly interests that hinder war production is planning for the future. That kind of planning endangers on delays the final successful completion of the conflict. It means that more men, women and children will die. On the other hand, if a guarantee of Freedoms to the American worker to the citizen of France, and to the native of India will stimulate them to redouble their efforts in fighting Fascism, each by his own method, then that is good planning.

However, just talking about post war plans is not enough. Past experience has made people skeptical about such promises. Such promises, standing alone, will not stir them to active cooperation. But, the future aims can be assured by the manner of meeting the current war problems. You will find, upon analysis, that effective prosecution now of the war against Fascism will carry with it progress and reinforcement of democracy after the war. Let me outline some of the pressing problems of the present which will exemplify this point.

ALL but a negligible number of selfish individuals favor the policy of an equitable distribution of the necessities of life and happiness. Instead of saying that we shall make that one of the objectives after the war, we decide to institute a widespread rationing system at once. What this does in building morale will be immediately apparent in improvement in the war effort. That is the kind of planning that counts.

Franz Boas' early work exploded the myths of racism. Readjustment of society, in this country, on this solid foundation of science, proceeded hardly at a snails pace. Now, with a critical emergency confronting us, there is a concerted effort to rectify a stupid situation wherein a few million Americans, because of skin color, or sex, or religious difference, have been prevented from contributing their full potentialities on the production front. That, too, is the kind of planning that counts. Mere lofty aims for the future are not enough. (Public Affairs Pamplet No. 75, "Where Can We Get War Workers?"—just off the press, presents a startling picture of our manpower situation as revealed by a survey in a representative industrial locality. It touches, among other things, on problems of training and discrimination. I highly recommend this little pamphlet.)

ANOTHER pressing problem of the day, of interest to the scientist, is the immediate mobilization of technology. Every professional organization of the nation ought to get behind the Kilgore and Tolan Bills, now pending in Congress. The New York branch of the American Association of Scientific Workers has made a thorough study of these bills and prepared an excellent report. This is so important that I shall give their address and urge you to write them for a copy of their conclusions. The address is 28 Washington Square, N., New York City.

Clutching to the heart of our production machinery have been the abuses of our patent system with deep rooted and far reaching monopolies and international cartels. Spread over the records of Congress are voluminous reports, hardly mentioned in the press, that deal with such pressing realities as our supply of aluminum, rubber, steel. We are not merely planning what to do about these things after the war. We are, though belatedly, making progress in overcoming these bottlenecks. A science teacher unfamiliar with this problem is behind the times.

Last, but, for the science teacher, not the least, is the urgency of technical preinduction training of secondary school students. True, this essential phase of education was neglected in the peacetime before the war.

(Continued on Page Twenty-eight)

Low Voltage Power Supply for the Laboratory

H. F. ARCHIBALD and PHILIP G. JOHNSON

Keuka College **Cornell University**

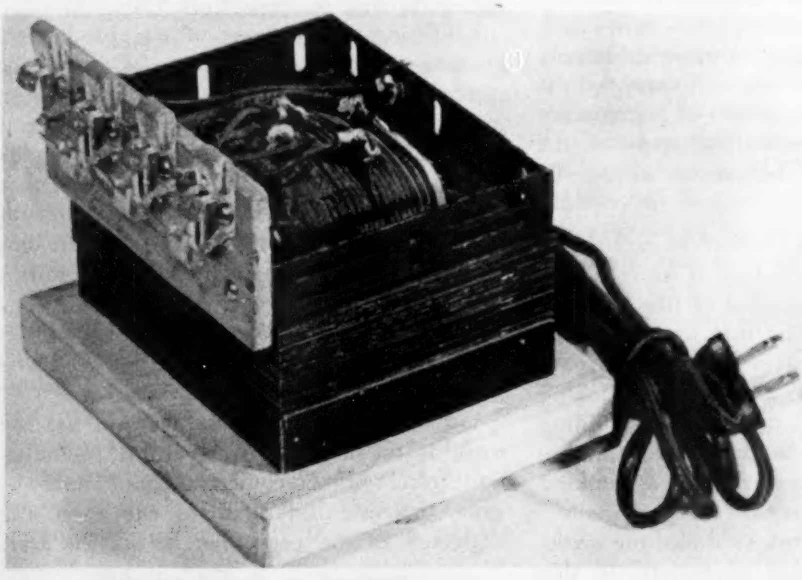
THIS is not an attempt to provide busy work for idle hands, but an honest effort to make available, to those who might have need for it, a method for making a low voltage power supply. In my own previous attempts at such construction, I ran against two difficulties. The first was that of securing and cutting transformer iron, and the second was with winding the transformer.

Several times a year, your local radio serviceman has to replace a burned-out radio power transformer. He usually throws the old transformer away, because from his point of view it is worthless. However, the transformer core is never damaged, and it makes a convenient source of ready-cut transformer iron of high quality. In addition to the core, the old transformer may yield wire which is usable, and if torn apart carefully, it will reveal the size of wire and the number of turns necessary for rewinding, as well as a fibre sleeve on which to place the windings.

TO convert the old transformer for laboratory use, proceed by removing the bolts holding the laminated core together. Next remove the strips of iron that compose the core. If you have to damage the first one in order to get it out, there will be no harm done, as one strip less will make no significant difference. Take them all out, remembering in a general way how they went together so that you can reassemble them later. Remove the old windings next, saving such wire as may be of use to you. In the center you will find the fibre sleeve or spool mentioned above. It will be of great help in making the new windings, as you can be sure it willl fit the core.

TO rewind the transformer, fit the fibre sleeve mentioned above with a wooden block through which you have passed a carriage bolt. Fasten the bolt securely with a nut and washer, so that it cannot revolve in the block. For a winding lathe, I used a twist drill held in a vice. By this method one can turn the coil just about as fast as he can run the wire on smoothly. At the start, secure the end of the wire with friction tape, and wind all the layers of the coil by turning the drill in the same direction so that the wire goes on in layers like thread on a spool. Each layer of

(Continued on Page Forty-four)



An easily built low voltage power supply for laboratory.

Needed --- A Consolidation of National Science Teachers Associations

FRANKLIN T. MATHEWSON

Editor of the Science News Bulletin

White Plains, New York

The views here presented are those of the author who has made a study of national science teachers associations. As in other areas, the journal pages are open to the presentation of conflicting ideas as a matter of stimulating thinking. — Editor.

FOR several years leaders in the various branches of science education have realized that a more effective national association and a better publication in science education should be available to science teachers throughout the nation. Since 1828 at least five national associations for science teachers have been organized. The following are of most interest to secondary-school science teachers. They are arranged according to the date of their foundation which is given after the title of each.

Department of Science Instruction of the N. E. A., 1894. Membership primarily classroom teachers and department heads; includes some supervisors and science professors in teacher training institutions. Reorganized in 1942 as the American Council of Science Teachers.

Division of Chemical Education of the American Chemical Society, 1922. Membership comprises both secondary-school and university teachers.

National Association for Research in Science Teaching, 1928. Membership is restricted to those who have published research for the improvement of this field, or have contributed outstanding service. Over three-fourths of the members are employed in teacher-education institutions.

American Association of Physics Teachers, 1930. Membership mostly college and university teachers.

American Science Teachers Association, 1934. Includes individual memberships but functions chiefly through the affiliation with several state, regional and a few national associations of science teachers.

National Association of Biology Teachers, 1938. Membership largely secondary teachers, with some university teachers chiefly from teacher training institutions.

THE years from 1934-1938 marked the emergence of two national associations and the revitalization of a third, The Department of Science Instruction. The writer, having been president of the New York State Science Teachers Association and having acted as a director on the board of two of the above national associations, sensed this national association problem keenly, believing the rivalry and duplication of effort among these associations to be wasteful and confusing to the classroom teachers of science—most of whom never belonged directly to any national association.

With this hypothesis in mind the writer included the problem in a research which he completed on the in-service education of science teachers.[1] A brief summary of the methods of research used and some conclusions reached is more easily available in a recent issue of *Science Education.*[2] Suffice it to say that in addition to a study of the literature and personal interviews over 500 questionnaire responses were received with representation from forty-eight states. They came largely from classroom science teachers, with representation of department heads, professors of science education, and administrators also included.

THE data shows that by far the most advisable relationship for science teachers' associations to have with general teachers' asso-

[1] FRANKLIN T. MATHEWSON, *A Study of the Contributions of Certain Professional Activities to the In-Service Education of Science Teachers in Secondary Schools.* Doctors Thesis (unpublished), New York University, 1941, pp. 449.

[2] ————————, An Evalution of In-Service Education Devices for Meeting Specific Needs of Science Teachers in Secondary Schools, *Science Education* XXVI (February, 1942), pp. 78-82.

ciations and associations of scientists is that of a single independent association allied and co-operating with both the National Education Association and the American Association for the Advancement of Science. This position was taken by 58.9 per cent of the respondents to the final questionnaire. A considerably smaller number of individuals, 20.7 per cent, believe that the national organization of science teachers should be a single association as a department of the National Education Association. Trailing third, with 11.9 per cent, is the desire for a single association affiliated with the American Association for the Advancement of Science. The least desirable situation of those listed, approved by only 8.3 per cent, is the existence of two national associations, one as a department of the National Education Association and the other affiliated with the American Association for the Advancement of Science.

Three interesting variations occur within the groups. Teachers in the smaller schools are less interested in affiliation with the American Association for the Advancement of Science in contrast with the teachers in the larger schools. Instructors with undergraduate preparation in teachers' colleges are more interested in affiliation with the National Education Association as compared with the liberal arts prepared teachers. A majority of the administrators believe science teachers should organize as a single association in the National Education Association.

ASIDE from the opinion of the administrators, the groups distinctly favor a single association affiliated with both the National Education Association and the American Association for the Advancement of Science.

The teachers of New England are much more in favor of the single association affiliated with the American Association for the Advancement of Science than are the teachers in other parts of the country. New York State and the cities of Michigan have the greatest interest in the single association with dual affiliation.

General science teachers favor the single association as a department of the National Education Association somewhat more than do the other subject teachers. The physics teachers give the highest rating, for all groups, to a single association affiliated with the American Association for the Advancement of Science.

THE only conclusion which seems possible after a careful consideration of over 500 questionnaire responses is that the best future national policy for secondary school science teachers should be a single independent association of science teachers allied and co-operating with both the National Education Association and the American Association for the Advancement of Science. The existing situation of two national science teachers' associations, one as a department of the National Education Association and the other affiliated with the American Association for the Advancement of Science, is shown to be much the least desirable of those considered by this study.

It does seem unfortunate that because of zealous professional spirit of several leaders who were attempting to do the right thing we have been maneuvered into the undesirable situation of having too many associations.

Permit me to quote from an editorial in *The Science Teachers News Bulletin*, the official publication of the New York State Science Teachers Association.

The co-operation of large numbers of teachers from various associations in the work of the National Committee on Science Teaching is a most encouraging sign of progress in professional attitude.

When the work of the committee and all its sub-committees is "finished" (if work of such a nature should be considered finished) and the reports published, what then? Shall we return to subject compartments, our feeble struggling associations, and our totally independent states, or shall we profit by the experience of the co-operative enterprise of the Natnional Committee and as its culminating work organize a national council of science teachers in which all national science teachers' associations composed largely of instructors on the elementary and secondary levels would be merged.

This does not mean that any one existing association should "swallow up" the others but rather that the associations of teachers on these grade levels might unite to form a new independent association allied and fully co-operating with both the N. E. A. and the A. A. A. S. Such an association would have

ON THE ROAD TO VICTORY

OUTSIDE the main gate at Corning Glass Works stands this big new Roll of Honor. On it are row after row of names—over 1,000 to date—from the sales force, office, laboratory, and plant personnel now serving in our Armed Forces.

Among these are names of field representatives of the Laboratory and Pharmaceutical Division. They called on you, in the past, to render a helpful service, to keep you advised of the newest developments in Corning Research. And they welcomed your suggestions or criticisms so that we could continue to make our ware ever better.

While they are serving as Corning's fighting representatives at the front, we who remain are carrying on. Although fewer in number, our field men will call on you as often as conditions permit. News of Corning developments in "Pyrex" brand, "Vycor" brand and "Corning" brand Laboratory Glassware will be brought to you by mail, by printed literature and by continuous advertising in trade publications.

You, in turn, directly and through your laboratory supply dealer, can help us to help you, by your comments and criticisms. Our "sights" have not been lowered. There will be no let-up in our efforts to supply you with constantly improved laboratory glassware.

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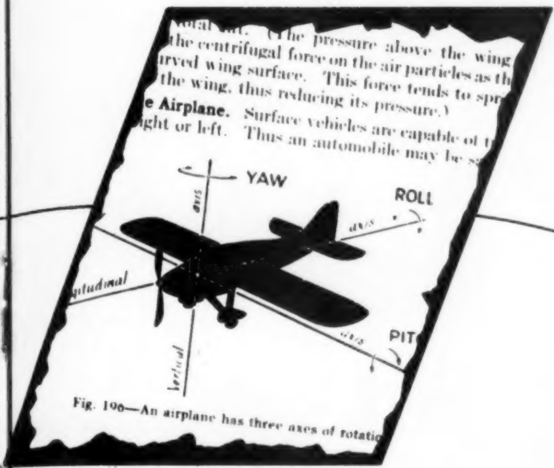

From MASTERY UNITS IN PHYSICS

UCTION .....both the new and the
red to war-time teaching. New war
new teaching devices [two colors
titles] make for faster learning.

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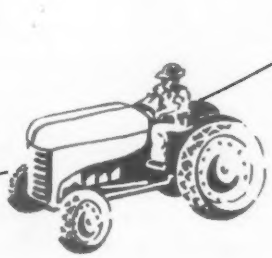
From DISCOVERY PROBLEMS IN BIOLOGY



sections for biology, physics, chemistry, general science, and possibly other groups of teachers. One can not dismiss lightly the hard work of the leaders who have struggled to build the existing organizations to their present level. We hope they will pool their skill and valuable experience in producing something more adequate to the needs of science teachers.

A "National Council of Science Teachers" might have three meetings a year, one in February with the A. A. A. S., one in June with the N. E. A., and another in December with the A. A. A. S. More important than "meeting" programs which benefit directly a small percentage of the membership would be its "year-round" program, including a superior, practical publication of ten or twelve issues and research by standing and special committees. Such an organization would need subsidizing for a year or two but with membership-subscriptions and the advertising support of publishing houses and apparatus and supply companies the proposed association should become self-supporting. (What would it not mean to business firms to have one publication with extensive circulation rather than the present multiplicity?) The publication should be more than a proceedings, and should have special subject departments as well as articles of general interests, abstracts, reviews and other services. A few pages could be devoted to state science teacher association activities, the space for each association depending upon their membership in "national council."

The end result should not be just *another* association and publication but accomplish an elimination of many of the present national associations for science teachers at the elementary and secondary level. This calls for enlightened leadership and self-negation. Pressure may need to be brought to bear upon some leaders.[1]

Types of Organizations for Science Teachers

ANOTHER problem of policy in science association work is whether associations, meetings, and publications should be organized for all science teachers (grades 1 to 12 or 14), have separate elementary and secondary groups, or go still further and have separate subject organizations in the secondary field.

The data of the writer's research shows there is great similarity in the judgments of the various groups, the only significant difference being in the preponderance of administrators favoring a single association. A plurality, but not a majority of teachers, favors a single association with a publication for all science teachers from grades one to twelve or fourteen. Next in favor is separate subject associations, with both united and separate subject associations practically tied for last place.

New England and California cities are least interested in a single association organization and give the highest rating to separate subject associations, in accordance with the pattern which they have followed for some time. New York State, exclusive of New York City, and the south and north central areas are most interested in the single association for elementary and secondary science teachers.

General science teachers are outstanding in their choice for a single association. Physics and geology teachers are least in favor of such an organization.

FROM these opinions one must conclude that a single association and publication, for all science teachers, grades one to twelve or fourteen is the most desirable form. However, such an association and publication must not become too generalized and should provide separate departments and section meetings for teachers in the elementary and secondary levels and in the several science subjects.

Suitable Dues for Membership

If a single association for all science teachers from grades one to twelve or fourteen, is to be established, one significant problem to be settled is that of dues; dues which will finance adequate services and the publication, yet not be so burdensome as to discourage many teachers from joining.

THE questionnaire asked what dues the respondent would be willing to pay for an annual membership in a national science teachers' association, if it had a program such as the respondent had outlined; such a membership to include also a science educational magazine with at least eight issues a year, bringing the services which the individual desired.

Data on file with the investigator show that the western teachers are more liberal

(Continued on Page Forty-five)

[1] Editorial, One National Association, *The Science Teachers News Bulletin* V (October, 1940), p. 10.

I Majored in Science --- So What?

MAX EPSTEIN

Haaren High School **New York, New York**

OUR national government takes a census every ten years to adjust its modus operandi — and so does the writer of this piece after a decade of dispensing scientific pabulum to all types of high school students.

Through all these years my students have acquired in their time a mass of orderly logical scientific principles, dressed up with a halo of scientific method and attitude, with available practical applications pertaining to the topic under consideration. How much of this do they remember after passing the Regents Exams with high marks? This criticism also applies to the non-crammers! How many students remember the principles of one science on taking the next science sequence? Have you ever been shocked by the lack of scientific transfer of training as displayed by students majoring in science?

The present science set-up in the high schools gives the student a sneaking impression that, having passed the course in general science or biology, he no longer has to remember that subject. He even feels outraged to be reprimanded for not answering properly. Didn't he get 85% in his former science course? Isn't a pass mark supposed to ring down the scientific curtain on the last science course? By what divine right of teachers' gall should the student be required to "carry over" from the former science course to the new one? Small wonder then that at the end of a three year course in science the average garden-variety-of student is left, at best, mentally deep in the doldrums without a scientific breeze to stir him on to the real objectives in science teaching. If confession is in order, the honest student will have remarked, "I've majored in science, so what?" Of course those students with an educational conscience may have a few brief pangs of scientific remorse. What a tremendous waste of time, money, and energy. Isn't this sufficient grist upon which we teachers should sharpen our critical scientific teeth?

While I salute my mental superiors who have prepared our present science curriculum, nevertheless, I unhesitatingly propose an innovation which I hope will not outrage their pet ideas of the present setup.

THE writer proposes a seminar course in science to be given in the senior year which will coordinate all the biological and physical sciences. This is not a review cram course conducted in an atmosphere of sterile scientific pigeon-holing of advanced information, nor an intensive and extensive study of scientific principles. This seminar would be conducted in the following manner. As the new popular monthly publications on biological and physical sciences come off the press —each article would be discussed in class from its practical value, personal, scientific, commercial, and theoretical viewpoint and serve as a basis for review of principles learned in all previous courses of general science, biology, chemistry, physics, and physiography. Oh, what a wealth of useful personal, commercial, theoretical, and practical information is thus made available for consumption. How much more interesting this material becomes when discussed by the entire class, each offering some new angle. The experiments cited or suggested or implied in these articles serve as splendid laboratory work for this course. The writer has tried this procedure with senior science students — after the final exams had been given — and has nothing but critical raves to offer. Both students and teacher went to bat, digesting each item — going to original sources, looking up references, redefining terms which had been discarded to educational oblivion. It's surprising to see how many theories are offered by students to explain a new discovery. Even practical application are usually proffered by enthusiastic pupils, followed by suggested experiments to prove the point. What a marvelous excursion into the ramifications of the scientific atti-

(Continued on Page Forty-six)

A Simple Detector of Heat Radiation

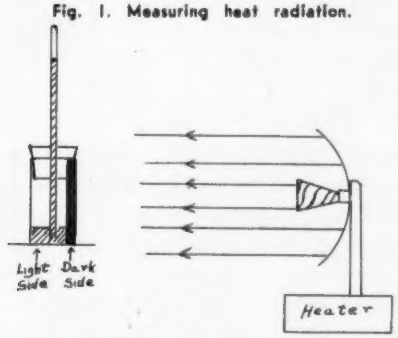
Replaces the Radiometer and Differential Thermometer

JOSEPH HEITMER

Bronx High School of Science **Bronx, New York City**

THE essential principle of the apparatus here described for the detection of heat radiation is that of the air thermometer. The unique construction resides in the nature of the bulb and its relation to the stem. The bulb consists of a thin walled can of copper taken from a discarded electrolytic condenser. One side is coated with black India ink on the outside. The other half-side is polished with a fine abrasive. A one hole rubber stopper with a long glass tube completes the construction. Diluted red ink acts as the indicator against a white background. The best source of heat radiation is an electric heater. When the black side is turned to the source of radiation, the indicator rises rapidly. When the polished side faces the radiation, the indicator goes down rapidly. This can be repeated indefinitely.

Fig. 1. Measuring heat radiation.



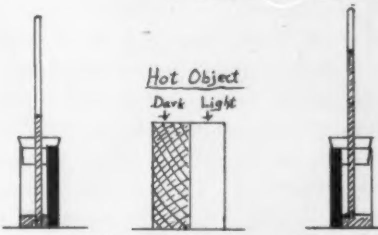


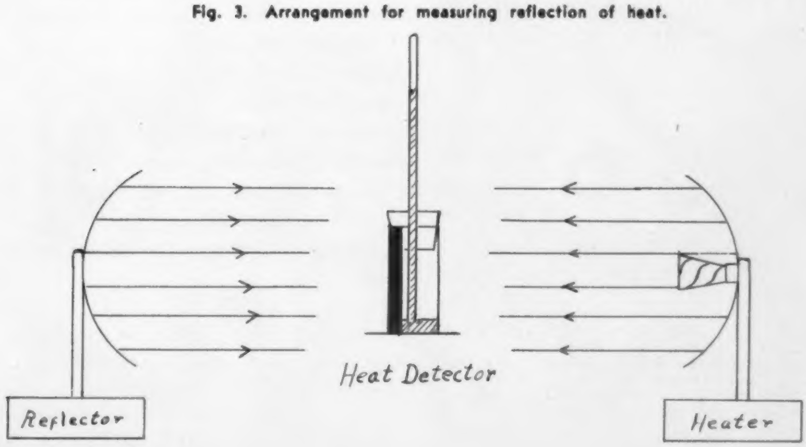
Fig. 2. Measuring radiation from a dark and from a shiny surface.

This detector can be used in many ways. In itself it demonstrates the qualities of dark rough bodies as absorbers of heat radiation as compared to smooth reflecting bodies. Using the black side only it acts as a sensitive detector of heat radiation in the form of a thermometer.

TO show the difference in emissive powers of black and shiny objects, use Tyson's apparatus (see Physics Club Demonstration, 1941) with the following modification. Instead of radiometer use the simple radiation detector first on the polished side of the radiator and then on the black side. Of course use the back, or sensitive side, facing the radiation. See Figure 2.

To show that heat radiation can be reflected use the arrangement as shown in Figure 3. Before the reflector is placed in position, little heat radiation is indicated. Afterward, however, a rapid rise will occur.

Fig. 3. Arrangement for measuring reflection of heat.



Variety for Junior High Science Class

JOHN J. COCHRANE

Roosevelt Junior High School — Rockford, Illinois

FOR a persistently successful science class in the junior high school a variety of procedure is vitally necessary. Exemplary classroom citizenship and desirable results in teaching depend upon the teachers' ability to provide such variety. One very simple method, providing for a student lead class, has proved highly successful as an occasional departure. In this class activity students not only think, ask questions, and solve problems, but they enjoy doing it.

Science teachers with acceptable texts may, with practically no preliminary preparation, inject this activity into their teaching programs on most any day.

Students must be selected by the instructor to occupy the positions of teacher, reader, and recording secretary. This may be done easily by asking for volunteers to hold up their hands. The instructor may then very quickly make the selections.

CREDIT is given for all contributions. The secretary records a point for every student who asks a question or satisfactorily answers one. The score of each individual is kept as the class proceeds. At the conclusion of the activity the recording secretary reports the results.

The teacher (student) directs the class. He requests the reader to begin reading orally while the others follow in their texts. At a suitable place he stops the reader and asks the class if there are any questions. Almost all hands will be in the air. These questions may be based on what was read, or there may be questions related to the subject of study. The teacher calls on one of them. When the question is stated, those who know the answer have their hands up. If the answer given is correct, the teacher approves and the secretary records a point. There are more questions to be asked so the procedure is repeated. This continues until there are no significant questions. If a question is asked which no one can answer, the student leader may call on the instructor. After a brief questioning period, the leader requests the reader to continue.

MARKED enthusiasm and thoughtful reading are evident during this activity. Students are very anxious to ask questions, and just as interested in the answering of problems offered by others.

Junior high school students in general science participate wholeheartedly. Many students have appraised this procedure as being of great help to them in their reading of science.

Such an activity is certainly no substitute for the many devices and methods used in modern science classes, but it is a desirable departure. Reading of current literature, such as science news sheets, may be handled with this plan.

For one day of variety and enthusiastic all-student participation try this activity. Students may ask for it after that.

SPIRIT OF FRANZ BOAS

(Continued from Page Twenty-one)

We are not just saying what we ought to do about it in the peacetime after the war. We are doing something about it now. This, our most immediate task, will consume a major portion of our energy. You have read, in the last two issues of this department, about preflight training. Numerous publications are available, at low cost, from the Superintendent of Documents. Ask for the list of technical manuals. Write also to the commissioner of Education, Washington, D. C., for free literature on the Victory Program.

Scientists and science teachers are descending from their ivory towers to pitch in and help win this war. The spirit of Franz Boas lives.

Wanted: More articles on demonstrations, projects, and other practical teaching activities.

INSECTS IN WAR TIME

(Continued from Page Seven)

scruples against such practices. But I believe that we should be prepared, not only to protect the North American continent from such entomological attacks, but also to retaliate with insect warfare, if the enemies make further moves in that direction. Possibly we should beat them to it, now, since they have already broken the time-honored international traditions against such practices.

INSECTS, when prevalent, have a profound effect upon the health of man in a great variety of ways. The annoyance they cause just by flying and buzzing about, often lead one to wish they would hurry up and bite one and get it over with. I am sure we would all be astonished by the results of an accurate census showing how much time is lost and how seriously human efficiency is reduced in all out-of-door activities in summer, how many accidents are caused by insects, and how tragically the enjoyment of all kinds of out-of-door sports is spoiled by the annoyance and fright caused by these pests. Their offensive odors and the unspeakably repulsive taste of their excretions upon berries and other fresh fruits cannot be ignored.

Following these mere annoyances, which however may lead to serious results, we come to the real phases of injury. By entering our eyes, ears, nostrils, stomachs, and other parts of our bodies, insects often do serious harm and lead to fatal illness.

NEXT is the matter of insect venoms. These venoms are applied in at least five different ways. By stinging and biting are the best known methods. In the foreign countries to which our armies are being sent are many viciously biting and stinging bugs, ticks, black flies, deer flies, stable flies, punkies, spiders, scorpions, centipedes, ants, wasps and bees, the like of which we in America have never encountered. They commonly cause hours of agony, indescribable suffering, illness, and sometimes death of the victims. All troops sent into tropical and subtropical lands should have a well-trained medical entomologist with them to guard against suffering and disablement from such direct and insidious attacks. As an example of how serious insect venoms may be, I may cite the well-known effects of chigger bites. Contrary to the common opinion, this tiny mite does not burrow into the skin. It merely inserts its mouth stylets, sucks blood for several hours without being felt and then drops off, leaving behind a venom which, considering the small amount that the tiny creature, only as big as the cross-section of a fine needle, could possibly inject, must be many times more potent than rattlesnake or copperhead venom. One of the most loathsome and bothersome of the biting insects is the bed bug, which has already been causing plenty of grief in our army cantonments.

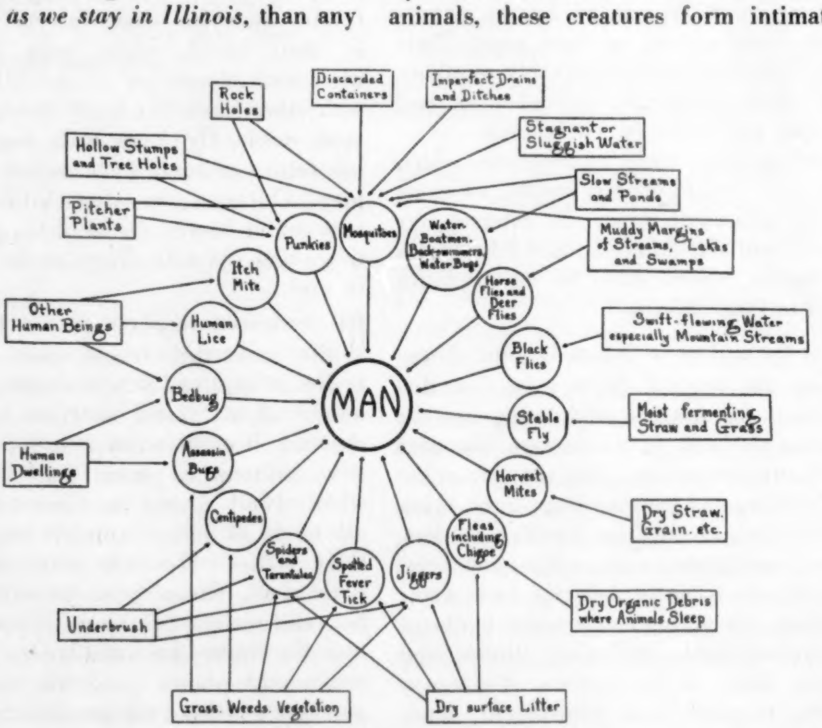
Besides the many stinging and biting pests, there are the nettling caterpillars, whose stiff body hairs contain an irritating venom introduced to the skin when they brush over our faces, arms or hands; the blistering or vesicating beetles that, when crushed against the skin, cause painful blisters due to venoms in their body fluids, though they have no sharp weapons for penetrating our flesh. And finally there are some insects with poisons in their blood, which may kill animals when such insects are accidentally swallowed with other food. The body fluids of the common stable fly have been found toxic to laboratory animals such as rats and guinea-pigs. Chickens are often killed by eating rose chafer beetles. Some of the grain insects, if ground up with flour, may cause illness in man.

OF increased importance are the parasites that make their homes upon or inside the bodies of man and other animals. These most-odious of all insect warriors include fleas, chewing lice, blood-sucking lice, mites and ticks, a total of more than 4,000 species which dwell among the hairs or feathers of all kinds of larger animals and feed upon their bodies. The itch mites, screw-worms, horse bots, sheep bots, ox-warbles, human bots and many other kinds of maggots tunnel into the flesh, like wood-borers in trees and non-woody plants, penetrate through nasal passages and head sinuses, attach to the walls of the stomach, or invade the urino-genital system, leading always to very serious trouble and frequently causing death.

It must be borne in mind then, that insects may themselves be pathogens; that is, their varied attacks may cause a diseased condition by direct contact, by feeding, by biting or stinging in defense of their lives or their nests, and by venoms deposited upon the skin or taken internally with our food.

THIS, however, is far from being the most important insect menace to our health. Other insects such as the common house fly, which can neither bite nor sting and has no venom, is so menacing to us as a carrier of other living organisms which are pathogens, including bacteria, protozoa and the eggs of parasitic worms, and depositing them upon our food, lips, eyes and dishes, that I have no hesitation in calling the house fly the most dangerous wild animal in Illinois. It is so abundant, so ubiquitous, so dirty, and so tolerated by man, that I really think it is more likely to cause your death or mine, by disseminating typhoid fever, tuberculosis, diarrheas, dysentery, ophthalmia, gangrene, and other diseases—a greater menace to our lives, *so long as we stay in Illinois*, than any other wild animal that lives in this benign, plague-free and salubrious area of the world. That is true only because we do not have any of the world's worst animal enemies within our bounderies. Dangerous as it is, the house fly is not the most sinister and harmful wild animal in many parts of the continental United States and in most other parts of the world.

By far the most serious threat to human and animal lives arises from a combination of domesticity (that is, a tendency on the part of the insect to live in our dwellings), the blood-sucking habit, and the fact that such insects almost inevitably spread from person to person the germs of many deadly diseases. In these days we have learned to look with suspicion upon alliances of any kind; and particularly when both parties of the alliance are notorious evil-doers, the hook-up is rightly viewed with grave alarm. In the relations of insects and the pathogens of disease we have an alliance between the two most terrible groups of mankind's enemies. By their contact with us and our valuable animals, these creatures form intimate and



Insect Satellites of Man.

The marginal rectangles state the various sources from which the biting and disease-carrying insects and related Arthropods named in the circles, develop, emerge and descend upon human beings for food or in self-defense.

intricate, three-party relationships involving us and the only two great biotic forces of nature which we have not yet been able to conquer, namely *first*, the insects, mites and ticks; and *secondly*, the disease-producing organisms — bacteria, protozoa, pathogenic fungi, parasitic worms and viruses.

THERE are of course various ways in which these pathogens can get from one human or animal victim to others, as they must in order to survive. But, with reference to scores of deadly diseases, the only way they can get from one host or person to another, is to be transported by certain insects. I call this *the morbific triangle*, because man and his domesticated animals form the apex of the triangle of interrelations toward which the full fury of these two groups has been directed.

The advantage of this alliance of the helpless, inactive protozoa, bacteria, and viruses with the active, hardy, ubiquitous and wide-traveling insects can hardly be overemphasized. Many of these pathogens have no method of moving from place to place without the aid of these "insect taxicabs." The insect carriers serve the disease germs better than our automobiles do us, for they are directed by an almost infallible instinct to go exactly to the place where the pathogens need to go — namely, to the animal from which that insect must get its food, and which is also the host within which the pathogen must be implanted in order to survive. The biting mouth parts of the insect also form a perfect hypodermic needle for injecting the pathogens into the blood or other tissues of man where the pathogens feed and multiply.

THE insects thus provide a snug moist shelter for these germ enemies of mankind, (many of which cannot even withstand exposure to dry air); they provide a winter haven, a reservoir, and a system of transportation, within which the pathogens can rest and feed securely as long as the insect lives; and, at each occasion when the insect bites a man or other suitable animal host, they slip some of their Fifth Columnists into our blood. Their immediate security and the welfare of their offspring is assured by the fact that, if there is anywhere at hand an animal in which the germs can live and multiply, the bloodthirsty instinct of the insect will find such animal and carry the germs to it with utmost safety and dispatch. From man's point of view this alliance between insects and disease germs is most insalubrious, for it multiplies and intensifies the damage that insects can do a thousand-fold.

Every school boy and girl knows about one of these morbific triangles; namely, that the only way man may be striken by malaria is to be bitten by a mosquito that is infected with the malarial protozoa. But many people do not realize that this is only one of more than a score of highly fatal diseases that are absolutely dependent upon insects to spread them from one person or animal to another, and often as a host in which they live during an essential part of their life cycle that cannot be passed anywhere else. Besides the cases in which the insect carrier is also an essential host of the pathogen, there are more than 200 other bacterial, protozoan, virus and worm diseases of man and animals in which insects, mites and ticks play a very important, though not always essential part as disseminators.

IN all past wars deaths from epidemics of insect-borne diseases have generally caused more deaths than the enemies' bullets, bombs and bayonets. It was typhus fever, more than the valor of Russian soldiers, that defeated Napoleon's "grand army" in Russia. In the Crimean War, the British suffered about 1,700 deaths from wounds and over 15,000 from insect-borne diseases. In the Boer War, less than 7,000 British troops died of wounds, while over 13,000 died of diseases, in addition to which 72,000 were invalided back to England, suffering from insect-borne infections. In the Spanish-American War, typhoid fever, spread by house flies, and yellow fever, disseminated by mosquitoes, were more devastating to our forces than the Spaniards. In Austria-Hungary in one year, ending in September, 1915, there were 27,500 cases of cholera, spread by house flies, and 15,270 deaths from that disease among the Mediterranean Expeditionary Forces. During World War I, louse-borne typhus fever caused over 300,000 deaths in Serbia and over 2,000,000 in Russia, in addition to which there were disturbing outbreaks of trench fever, also

spread by "cooties," on the Western front. And the insect menace in the present war in the South Pacific, in West and Central Africa, and in the Mediterranean areas we believe presents a problem second only to the necessity of supplying our forces with food and munitions. There have been a number of threatening outbreaks of typhus on the continent of Europe. And it is generally admitted that it was malaria which caused our defeat in the Phillipines.

EVERY great war in the past has also been followed by widespread, deadly epidemics of diseases, in parts of the world remote from the battle fields, due to the introduction of infections by returning soldiers or by prisoners of war. These have often lead to losses in civilian lives, greater than those inflicted upon the armies during the conflict itself. An epidemic of louse-borne typhus fever killed more than 10,000,000 people in the Balkans and the Ukraine, immediately after World War I. The most rigid inspections and precautions, by persons having an intimate knowledge of the appearance and habits of insect-carriers of diseases, will be necessary to prevent the spread of deadly infections into the United States, by troop movements during and following the war. Recently louse-infested Italian war prisoners have been brought into the Middle West, which might start an epidemic of typhus among associated service men and civilians. The inevitable lowering of resistance and sanitary standards, due to the war privations we may have to endure if the struggle continues for several years, so as to lead to universal impoverishment and a general breakdown of sanitary conditions, both among troops and civilians, is very likely to be followed by devastating post-war epidemics. To keep the insect-borne diseases from becoming established in this country, trained medical entomologists must be engaged to cooperate with physicians and bacteriologists to render a vital service.

There seems to be a very widespread error of assuming that physicians, sanitary engineers and bacteriologists are all that are needed to protect our troops from diseases. But they are not adequate and competent to control the all-important insect-borne epidemics. Except in cases where effective immunizing vaccinations have been developed, the control of these diseases depends upon the control of the insect vectors. Even in cases where immunization is possible, as for yellow fever, it is obvious that the eradication of the insect carriers gives the most satisfactory, and the only permanent control. In Africa, where Bayer 205, Tryparsamide and Atoxyl have been used to destroy the trypanosome pathogens of sleeping sickness, it has been found that in areas where such chemotherapy has been used for a long time, the trypanosomes have acquired resistance to the drugs which threatens to render such control useless. Hindle has well said: "The only effective way of suppressing sleeping sickness is by killing the tsetse fly carriers." So the control of this and many other insect-borne diseases is a problem for men trained in medical entomology. Prevention is so vastly more important and desirable than attempts to cure diseases, that entomologists should be engaged to aid physicians and sanitary engineers, by performing the duty of insect control, for which they alone are qualified and competent. The British, because of their long and intimate contact with tropical insect-borne diseases in Africa, India, Malay, and other of their colonies, appreciate the importance of entomology vastly better than our administrators do. I understand that every British expeditionary unit includes at least two trained entomologists for every one hundred troops.

INSECT control under camp conditions presents many problems that cannot be anticipated. Only broadly and technically trained men, alert to the probable versatile attacks of these six-footed enemies and familiar with control operations that may control them under varied conditions, can be depended upon to meet such emerency conditions. Every one of our expeditionary units and every army and navy training camp on this continent should have some well-trained entomologists attached and given a rank that will assure respect for, and adoption of, their recommendations. And the larger the percentage of our men in the service, as well

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SYNTHETIC RUBBER

(Continued from Page Thirteen)

resistant to deterioration in sunlight and air, to abrasion, and to softening and solution in oils and greases. This has led to extensive use in such special applications as gaskets and hose for gasoline lines, special conveyor belts and barrage balloons. In spite of a price three to four times that of natural rubber Neoprene production has more than doubled in each of the dozen years it has been on the market. At the present time, expansion of Neoprene production to 40,000 tons a year is planned. This is a small, but nonetheless highly important, part of the synthetic rubber program.

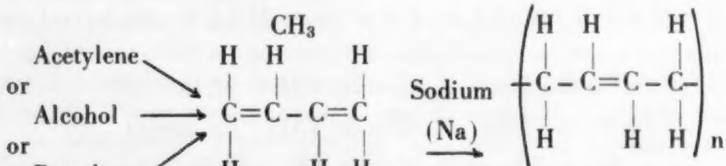
THE product which will form the bulk of our synthetic rubber is *Buna S,* which is based on the parent substance, butadiene itself. It has long been known that butadiene will polymerize to a rubber-like material which has been called Buna rubber. The name is derived from the first two letters to butadiene, combined with the chemical symbol for sodium, used to catalyze the polymerization.

It is a curious fact that the three principal countries which manufacture Buna rubbers —Germany, Russia, and the United States—each base their commercial synthesis on different raw materials Germany uses acetylene, prepared from coal and limestone, Russia uses alcohol, prepared by fermentation, and the United States uses petroleum, with considerable additional production from alcohol.

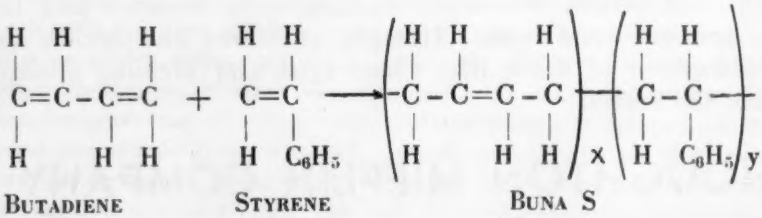
IT has been found that inclusion of some 15 to 20% of styrene in the butadiene leads to a polymer containing both substances. It is known as *Buna S* and has mechanical properties superior to those of Buna rubber itself. This polymer is analogous to a chain constructed of two different types of links. Substances of this type, built up of a more or less random arrangement of different types of units, are known as copolymers. Thus, *Buna S* is referred to as a copolymer of butadiene and styrene and is built up of butadiene and styrene units in the long polymer chain.

Over 400,000 tons of Buna S will be made in 1943, over 700,000 in 1944

Butyl rubber, one of the newest synthetic rubbers, is an American development. It uses isobutylene, readily available from petroleum, and just enough isoprene or butadiene (1 or 2%) to give material with a few double bonds to react with sulfur in vulcanization. There will then be no reactive double bonds in vulcanized butyl rubber and it is therefore extremely stable to chemical decomposition. Such reagents as strong acids or ozone, which rapidly disintegrate natural rubber, leave butyl rubber unaffected. The economic possibilities indicate that butyl may



BUTADIENE BUNA RUBBER



BUTADIENE STYRENE BUNA S (x:y::4:1)

eventually be the cheapest synthetic of all. Present plans call for the production of butyl rubber at the rate of 132,000 tons a year by 1944.

IN addition to the substances discussed above, which might be considered to be rather closely related to natural rubber, there are a variety of substitutes for rubber which are quite unrelated chemically. Their only claim to chemical relationship is that they too are polymers or "giant" molecules.

Included in this group are such materials as Thiokol, one of the earliest useful synthetic rubbers (1922) and Norepol, one of the most recent. Thiokol, prepared from ethylene, chlorine and sulfur as the basic raw materials, can be used in contact with gasoline and to make satisfactory light-duty tires. Norpol is a recent development of the Northern Regional Laboratory of the Department of Agriculture at Peoria. It is prepared from soybean oil and one of the ingredients used to manufacture nylon. It shows high promise of becoming a useful product.

IN addition to the various synthetic rubbers, there are a variety of plastics which can replace rubber in many applications. Mention might be made of Koroseal, for waterproofing cloth, Resistoflex, for protective gloves, and Styron, ethyl cellulose, Bakelite and others, for electrical insulation. These substances are not considered as synthetic rubbers because although they too are polymers, they are only plastic, not elastic.

In closing, I should like to say that, given a few years to learn the tricks of economical synthesis of the starting materials, to learn the best ways of putting the small molecules together to make the "giant" rubber molecules, and above all to learn the highly important art of compounding the various synthetics for the particular use desired, it seems highly likely that the synthetic rubber industry will have developed a product so economical and so superior that natural rubber may never recover the market the Japs have now so effectively cut off.

EMPHASIS IN PHYSICAL SCIENCE

(Continued from Page Nine)

apparatus. This suggestion applies particularly to the schools in the agricultural communities. In a serious study of meteorology it should be possible to construct suitable rain gauges, barometers, and hygrometers. Graphs can be used in very practical and convincing manner in connection with weather records.

If you are in a rural community, take an active part in helping apply scientific principles to the increase in food production, improvement of methods of preserving foods, and in reducing decay, corrosion and other losses. The care of farm machinery is a practical problem in which science should be interested. Home refrigeration and home canning will present problems which cannot now be solved simply by going to the hardware store. Dehydration of foods for preservation is after all a problem in science.

THE importance of mathematics as a tool for use in scientific exact work, especially as related to the war, should be emphasized. Teachers can develop a supply of very realistic and stimulating problems utilizing war situations. Physics teachers can use the newspaper statements that planes can dodge anti-aircraft shell by changing line of flight after they see the flash when the gun is fired. They also read that a ship, such as a destroyer, may travel a quarter of a mile after a bomb is dropped from a plane before the bomb reaches its target, thus having opportunity to escape by changing course. Aviation, navigation, and mechanized warfare provide interesting background for thousands of problems. If you can still get slide rules readily, and I am advised that student-type rules are available, by all means teach the use of the slide rule in physics, chemistry and mathematics.

If all American youth of today are to become "air-minded," why would it not be stimulating to use an airplane instrument board as a starting point for an entire physics course? Study of the instruments, learning why and how they work, would make quite a physics course.

A PROBLEM stimulating to most chemistry students would be the making of the very best possible incendiary bomb, using common inexpensive materials, and making the bomb as foolproof as possible. Immediately following this, of course, would be the project of determining the safest and most effective method of dealing with incendiaries in a bombing raid.

Another project for physics might be a study of the problems in camouflage and of "lights-out," or use of lights to deceive bombing pilots.

Such homely and important problems as care of anti-freeze solutions, determination of tire pressures actually giving maximum mileage, might stimulate interest. Although there is perhaps little danger of war gas attacks in this area, many students would be interested in study of and preparation of decontamination agents to be kept in home or school ready for use. Complete instructions for preparation of war gas identification sets may be found in the August, 1942 issue of the Journal of Chemical Education. This article includes methods for preparing the agents themselves. Many smaller communities would surely profit by organization and training of student volunteer chemical fire-fighting groups.

Physics teachers can contribute by stressing mechanics, heat, radio and electricity, and photography.

WHY not team up with the physical education and home economics people to get really insistant about health through improvement of diet? Utilize data from local medical boards and draft board rejections. Make a real effort to influence home diet and cooling procedures. I understand that about 80% of all applicants for the Marines are now rejected because of physical defects. 27% of all Marine officer candidates, all college graduates, wash out because of physical failures. Lt. Jay Berwaner, Naval Aviation, stated recently that only about 6% of our youth of today are physically fit for combat aviation.

A project involving actual laboratory work might be developed to study the percentage of actual recoverable tin from tin cans. It

is at least remotely possible that this could be undertaken as a lare scale project in towns not now having such service. Possibly some local work can be done on substitute material for fruit jar rings, as well as development of nearby limestone deposits, etc.

For something really exciting and spectacular, organize a glider club and build a primary glider. This is an undertaking of real magnitude, which might not be restricted to people of high school age. Such projects are feasible and are being carried out successfully.

EVERY effort should be devoted, in my opinion, to interesting and informing students about what is going on now and what will happen in the future rather than what was so in the past. Stimulate the imagination to wonder what the world will be like after the war, with progress in such fields as medicine, fuels, automobiles and planes, light metals such as magnesium and aluminum. If we can really prepare students to expect a world changed in many respects, that in itself may be a real help in preparing them for the parts they are to play in later years. Certainly you can emphasize the fact that our country and the world needs highly educated, trained technicians, scientists and workmen rather than just common laborers.

The change in demand for farm products can be emphasized by many teachers. Perhaps people of the corn belt should be prepared for a revolution in scientific agriculture.

The scientific principles involved in the present search for and development of substitute materials can be pointed out in an interesting manner. These principles can be discussed in connection with a study of rubber, tin, silk, etc.

I WELL recognize that there is nothing new in these suggestions. It really amounts to making the subject more practical or more closely related to the environment of the student. Theory is approached only through practical, close-at-hand applications. Some people would say that these recommendations sacrifice permanent values for the more immediate need. Perhaps so, but I doubt it. At any rate, if the suggestions stimulate you to a more careful examination and criticism of the work you are doing, it will be worthwhile regardless of your final choice.

You will find daily newspaper, magazines, and technical periodicals full of situations which can be utilized in the science teaching work. *Chemical and Engineering News*, the American Chemical Society news publication, is worth careful reading. Many government publications, such as the War Department TM and others, are available as source materials.

Those of us who have left the teaching profession, at least temporarily, look to you who remain to carry on the job. In fact, with so much deadwood removed, and under such exceptional stimulation by present conditions, real progress and improvement should be made. Some people say public education has failed — that it must improve or perish. You are the ones who must sacrifice by longer hours of toil to be of more real service to your students, your community and your country.

APPLYING NEW PROCEDURES

(Continued from Page Fifteen)

ily developed in the first ten weeks, and showed a satisfactory mastery of these essentials, in general. It is still too soon to draw any very sweeping conclusions, but we do have evidence that the boys like the work, and that they are learning a great deal of chemistry.

I probably will be unable to "beat you to the draw" in suggesting a formidable list of reasons why such a procedure could never be used in your classes. You have no research laboratory handy. There is no research chemist to give his time as an instructor. Your classes are far too large. Your periods are far too short. So be it. But if, perchance, there are some here whose chemical knowledge is not all book knowledge, who would rather test something experimentally themselves than to read of others' experiments; if there are some who actually practice what they preach to their students about home laboratories, then to you I have this to say. There are plenty of simple, practical chemical problems yet unsolved. Look about you. Pick up one of them as a hobby. Develop it to the point where you begin to get results. Then see what you can do about using it to teach chemistry by using real problems.

THE second new procedure illustrates the use of the materials and methods of science to deal with a mildly controversial topic— "Which brand of peas shall I buy"? The information upon which this account is based comes from Mr. David Aptekar of Northwestern High School of Detroit.

By chance, one of the members of the class asked what "Grade A" on a can of peas meant. This gave the teacher an opportunity to arouse interest on the subject of grade labeling. The class wanted to know if an experiment on grades of peas might be feasible in our laboratory. It was agreed that, at the following meeting, a half dozen students would bring in various brands of canned peas. These would be used as the basis for a grading experiment.

Seven different brands of canned peas were brought in. These were placed on the desk around which the students had gathered, and the teacher raised the question as to how we were going to set about to grade these materials. The students suggested the following points of comparison: brand, size of can, price, where purchased, number of imperfect peas, weight of contents as listed on label, and actual weight, weight of solid content, clearness of liquid, uniformity of color, uniformity of pea size, tenderness, flavor ,and finally grade.

The class realized that if each of them were to do all of these things, the experiment would be very long and drawn out. Someone suggested that committees be given responsibility for certain portions of each of the items to be tested, and that finally a chart be drawn up, on which this information could be compiled.

THE discussion brought out the fact that in order to be unbiased in the matter of taste, flavor, and so forth, it would be best to remove the labels and judge the contents objectively. One committee set to work removing the labels and handling the clerical work, that is, the recording of data. Another group was set to work studying labels, and still another group was put to work weighing the contents. The larger group graded materials on the basis of tenderness, flavor, uniformity of size, and color. Students decided not to confer with each other in their evaluation, in order to get a fairer judgment. As the data was gathered, it was put on the chart, and this chart was made available to everyone in the class. The students were then asked to write out as many conclusions as were evident from the data collected. The students concluded:

1. That price was no criterion of quality, and that certain "premium quality" brands could not be identified after the label had been removed.
2. That the actual weight of contents in all cans tested exceeded the weight given on the label.
3. That there was a wide diversity in the actual weight of peas which came in different cans.
4. That there was a considerable variation in clearness of the liquid, and that a

darker liquid was associated with a poorer flavor in peas.

5. That pea size varied considerably in all grades of peas.
6. That the smaller peas were not necessarily more tender than the larger ones, or vice versa.
7. That all brands labeled "Grade A" were also judged "A" by the students, and that those which had no grade labeling were, in these instances, of inferior quality.
8. That there was a considerable variation in the information put on the labels which would aid the consumer in judging quality.
9. That there was a need for more information on all labels as an aid to intelligent consumption.

THE laboratory exercise we have just described is but one part of a much more extensive course in consumer chemistry. Any such course must be largely individualistic. It would be impossible to bodily transport this course of study to a situation where available materials and student interests are quite different. It is possible, however, for an aggressive teacher to do a great deal in the development of methods for objective evaluation of the things we consume. For all students, consumer aspects of science are valuable, whether their needs are those of the industrial city, the agricultural community, or the universal needs of consumers.

The final procedure to be described involves the solution af a laboratory problem. It is not a very good illustration of the idealized "steps" in the scientific method, but it probably comes much closer to the actuality of scientific procedure. Of course, the situation is planned so that the probability of success is considerably greater than in the typical pioneer experiment.

The problem is the laboratory preparation of methane. We give to each student a slip of paper bearing the following information.

(1) Sodium acetate reacts with sodium hydroxide to give methane. (Use structural formulas to "see" the reaction)

(2) Finely divided sodium hydroxide is best obtained in the form of sodalime, a mixture of approximately equal parts of sodium hydroxide and calcium oxide.

(3) In the presence of water, reactions between the sodium acetate and soda lime which do not produce methane are possible.

(4) Molten sodium acetate will attack the glaze on porcelain.

(5) Methane is slightly soluble in cold water.

IT was expected that the students would recall from their own information the following facts.

(1) Heat generally increases the rate of a chemical reaction.

(2) Water of crystallization can be given off by heating the crystals.

(3) Solubility of gases in water generally decreases with increase in temperature.

The job of the students, in preparation for the laboratory exercise, was to write out the procedure which they planned to use for the exercise. In order to do this they needed to draw upon the information given as well as information previously learned. They were required to think the problem through very carefully in order to fit this information into a logical plan. They had to make use of chemical calculations to determine the quantities of materials to be used.

The procedures the students submitted were checked only to eliminate potentially dangerour procedures. It was expected that the results of the exercise would be the best indicator of other errors. The student who tried to collect the gas by downward displacement of air could not tell when his bottle was filled. The boy who forgot to allow for the calcium oxide in his calculations of needed sodium hydroxide got a very poor yield. In general, however, the students were quite successful in planning and carrying through this laboratory exercise. The same procedure has been used on other experiments with equal success.

IT SEEMS quite likely that an entire course in chemistry could be built around this procedure by using each bit of information presented to solve a particular problem. In-

stead of having him read the authors explanation of burning; let him read a few briefly stated fundamental facts; let him perform a few simple experiments; and then let him formulate his own explanation. One might get some neo-phlogiston theories, or worse, but at least there would have been some thinking done, and the basis for an intelligent discussion would have been laid. With a few exceptions our textbooks in chemistry become larger and larger. An up to the minute text must treat all of the recent advances in chemistry in order to be considered complete. It must also include almost all of what has appeared in any previous text. Small wonder that our students become confused and lose interest when confronted by such a "wealth" of material. The average chemistry text does a much better job as a reference book than it does as a teaching instrument. A number of the better workbooks are taking over from the textbooks the task of guiding the learner. Yet even in them the major stress is on facts learned, not on problems solved. In a science class, I submit to you, that is not right.

THUS FAR we have covered briefly the program of the National Committee on Science Teaching, the fundamental requirement of good teaching in science, which is to put forth the effort to do well the things we already know how to do, and three illustrations of effective procedures which dealt with the practical problem of magnesium extraction, the consumer problem of grade labeling, and the problem approach to a laboratory exercise. There remains one further item to cover.

Educational programs are being dislocated by the war. Now more than ever before we need to build a science program around pupil needs, recognizing the twofold problem of victory and reconstruction. Teachers and students need to concentrate as never before on getting things learned. We have no time and energy to waste on half-hearted learners. We have no right to inflict poorly planned lessons on our pupils. Problem material in science should be built around practical situations; practical in their relation to winning the war, and practical in their relation to better living after the war.

INSECTS IN WAR TIME

(Continued from Page Thirty-three)

as in essential civilian work, who have taken at least an introductory course in entomology, the better they will be able to protect themselves and their associates from the dangerous insects that will certainly attack them.

Thorough inspection of incoming and outgoing troops and prisoners of war, to make sure that they are not conveying dangerous pests on their persons or in their baggage; protection of the food supplies both from waste due to infestation by insects and from contamination by disease organisms spread by insects; advice and guidance in the location of camps and cantonments to avoid areas where mosquitoes, tsetse flies, chiggers, ticks, black flies, horse flies, sand flies, and other serious pests are prevalent; the proper disposition of camp refuse to avoid contamination of foods by house flies and cockroaches —those are some of the important duties, in addition to the destruction of infestations of lice, fleas, bed bugs, cockroaches, mosquitoes, ants, termites, clothes moths, carpet beetles and food-infesting insects, which only men having entomological training can be expected to perform.

SUCCESSFUL control depends, first, upon ability to determine the exact species of insect involved. Species so similar in appearance that only an entomologist with a microscope can distinguish them, commonly differ so greatly in habits that one of them may be of no importance and the other a menace of the first rank. Also, a control measure 99 per cent effective for one species of pest may fail utterly for a closely related and very similar-looking one, because of their different habits. Consequently insect control demands technically trained men, just as airplane construction, ship-building and other engineering projects do. Such technically trained men can be made available in ade-

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DETERMINATION OF VITAMINS

(Continued from Page Eleven)

to them. All tubes are made up to 10 ml., sterilized to destroy all other organisms and then inoculated with lactobacillus casei. They are incubated for 72 hours. The amount of lactic acid produced in each tube is then titrated with tenth normal sodium hydroxide.

If everything has gone well, and it often doesn't, a standard curve such as is illustrated is obtained. The reading at 0 is due to a small amount of vitamin that is left in the media. The sample values must be below 10.3 ml. of sodium hydroxide. When the peak is reached it is impossible to tell what part of the curve a sample reading is on.

SUPPOSE one of our samples was dry milk solids, the solid portion of skim milk. We started with 5 grams in 100 ml. Through various dilutions we finally had an extract so that 1 ml. was equal to .002 of a gram of dry milk solids. From the data in Table 1 the value of 20.75 mg. of riboflavin per gram of dry milk solids is obtained.

TABLE I.
Riboflavin Assay of Dry Milk Solids.

m.l of extract	Titration ml. of N 10 NaOH	Micrograms of riboflavin g.	Micrograms of riboflavin per cc. of extract
1	2.6	.044	.044
1	2.5	.042	.042
2	4.1	.080	.040
2	4.3	.085	.0425
3	9.5	.210	.070[a]
3	5.5	.114	.038
4	7.45	.160	.040
4	7.65	.165	.041
5	9.50	.210	.042
5	9.95	.220	.044
		Aver.	.0415

$.0415 \times \frac{1}{.002} = 20.75\ \mu g$ gm. of dry milk solids.

a. Sample is too far off. Value was not used.

This method is similar to that for several vitamins. Nicotinic acid and pantothenic acid are determined by acid titration. Some people prefer to measure turbidity. This is possible because the organism can be suspended in the solution by stirring and the turbidity produced can be measured in a photelometer. This is done for riboflavin in some laboratories.

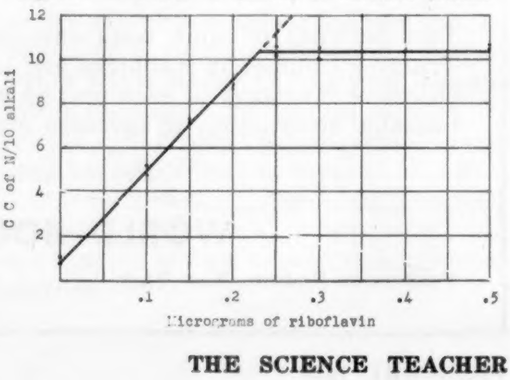
Thiamin is determined by yeast growth. The bacteriologist put a tongue twister, saccharomyces cerevisiae, on this organism. The Texas Bulletin describes a method using this material and measuring the amount of turbidity. It is so sensitive that the quantity measured is .001 of a microgram.

Schultz, Atkin and Frey have measured the stimulation of carbon dioxide production caused by thiamin on a baker's yeast media. The proper conditions of media, temperature and acidity are established. The solution is shaken and the volume of carbon dioxide given off is measured. This method is used in a range of 1 to 4 micrograms. Laboratories that have used it report good results.

THE microbiological method is used for many materials that have not been established as necessary factors in human nutrition. Folic acid, pyridoxine and pantothenic acid are a few. As might be expected, it is very valuable to the bacteriologist. Using it they can assay their media for various materials. Also, it has been a great stride forward in finding the factors necessary for bacterial growth.

Perhaps we should examine it closely for utility as a method of vitamin analysis. First, how accurate is it? In general, when the technique has been thoroughly worked out it has an accuracy of 5 percent within the sample and a 10 percent overall accuracy. That is to say, duplicates should check within 5 percent of the average and the final result should be within 10 percent of the correct

Amount of alkali used indicates rate of growth of an organism in relation to quantity of riboflavin present.



value. Second, does it work on all types of materials? This point has not been thoroughly investigated but some materials have given poor recoveries of added vitamins. It is probable that this can be overcome by modifying the method but each laboratory should use recoveries to test this point on the materials they are interested in. Third, how does it compare with other methods? This is a difficult question to answer without prejudice. Years of experience have given some laboratories great confidence in their animal assay. Nevertheless the microbiological method has undoubtedly furnished us with more complete vitamin assays in a few years than were obtained by the animal assay method in five to ten times as long. It is more difficult to compare this method with the chemical method. Where the chemical method is sufficiently well established and sensitive enough it is the better but there are not very many cases like this.

ONE point to be remembered is that the chemical method usually is specific for one particular chemical compound. Man and animals often are able to get the vitamin needed from several different chemical compounds, some of which may not be known. The microorganism is very specific in some cases and less in others. The animal assay certainly finds all the possibilities for the species involved but one must be careful in using these results for a different species.

What is the future of the method? Unquestionably the bacteriologist will find many uses for it. When it comes to vitamin analysis for human uses, it will be in competition with the chemical method. Both of these will undoubtedly be improved very greatly in the next ten years. The microbiological method should be valuable for some time to come and is certainly a very valuable tool at the present time.

It might be well to close this article with a word of warning. The microbiological method is simple in technique but has not been easy for laboratories to adopt from the litera-

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A POWER SUPPLY

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the primary should be separated from the next by a sheet of paper stuck down with orange shellac. It would be well to cut paper into strips of the proper width and length for this purpose in advance of the winding operation. A primary winding of 440 turns of number 22 enameled copper wire (magnet wire) is about right for a radio transformer core. If you wish you may duplicate the size of wire and number of turns in the original primary, but lacking that information, the above winding will be satisfactory. Cover the completed primary with a layer of friction tape, and a coat of shellac. The secondary is wound directly over the primary with number 18 bell wire. Wind on 20 turns as a first layer, and a second layer of 20 turns with a short twisted loop brought off at the end of each four turns.

WHEN the winding is complete, reassemble the core inside the coil, and secure the pieces with the original bolts. Attach a piece of lamp cord fitted with a plug to the primary and connect the ends and taps of the secondary out to a row of clips or binding posts. Mount the transformer on a small board so that the curious students can see how it is made. You will note that the taps on the secondary are so arranged that you can vary the voltage from 5 to 10 volts in one volt steps or from 1 to 5 volts if you start from the other end of the coil. These transformers are usually rated from 80 to 150 watts, so you will have plenty of power for most uses. The total cost of parts, as listed in the catalog of one of the nationally advertised radio parts supply houses, as about seventy-five cents. The transformer may also serve as a D. C. supply if equipped with one of the replacement type copper oxide rectifiers supplied for trickle chargers. This will cost an additional three dollars or four dollars, but you will have a substation of much general value for laboratory and demonstration work in physics and chemistry.

INSECTS IN WAR TIME

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quate numbers, if only our military and naval administrators and other authorities will realize their importance in winning the war.

For the reasons cited above and others that might be mentioned, I have a strong conviction that entomological training of men in the service is essential to the national health and safety and to our successful war efforts. And because of the great importance of having adequately trained entomologists, not only in the army and navy, but also on our farms, in food-production and storage factories and storage plants, and everywhere else that service men or civilians are concentrated, we should be training a considerable number of men, both enlisted men and regular students, in this subject, at universities which are competent to give such training. It is as important as training in engineering, medicine. chemistry, physical education, etc.

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SCIENCE ASSOCIATIONS

(Continued from Page Twenty-five)

and those of the south are less willing, or less able, to afford the larger amounts for dues. The data for secondary teachers show that 22.3 per cent of the group reporting are willing to pay five dollars ($5.00) or more, 60.7 per cent are willing to pay three dollars $(3.00) or more, and 88.9 per cent are willing to pay two dollars ($2.00) or more, and over 99 per cent are willing to pay one dollar ($1.00) or more. Professors of science education are some what more liberal.

In applying these data to the national situation one must remember that in this study we have a somewhat selected group with high professional interests, shown by these individuals taking the time to fill out the long questionnaire. Therefore it is doubtful if the rank and file of science teachers would be quite as generous. In recognition

of the above situation one must conclude from this study that dues above two dollars would discourage a considerable proportion of full time science teachers from membership. If possible the amount should be less.

A FAIR representation of teachers have spoken. Why not let them have the type of organization they desire — the kind that will promote science education best in America? Let's consolidate several of our all too feeble national associations into one really effective one with a program and a magazine that no science teacher could feel he could do without.

MAJORED IN SCIENCE

(Continued from Page Twenty-six)

tudes and methods this seminar offers. Somehow, the students feel that they are doing research work on a living integrated science that is up to the minute in age and importance.

OF course many of my critical die-hard colleagues will see the author running the risk of outsmarting himself. Yet spoof yourselves as you may, proper planning of this course will tend to coordinate and perpetuate science as a living hobby or preparation for a profession. It makes a follow-up in science work or literature a pleasurable task. This seminar course makes the practical science of today part of the individual today and not that material to be put into text books years from now. Isn't this a valid criticism of the best text book which becomes antiquated by the time a student thumbs its pages for current practical applications of science?

Realizing that as a science curriculum maker I'm only a pretender, I nevertheless hazard the prophetic guess that some day this science seminar course will take its rightful place alongside the sacred scientific cows in the present high school course of study in science. Why not try your hand with this proposed science seminar this term after the final exams before precipitating it into the waste basket.

BOOK SHELF

FUNDAMENTALS OF RADIO. E. C. Jordan, et al. Prentice-Hall, New York, 1942. 400 pages, $3.75 list.

THIS book is recognized as the standard text in the Signal Corps Reserve Courses in the elements of radio communication. It covers the field quite extensively and rather concisely, beginning with a chapter on mathematics and one on D. C. circuits, then developing AC principles, modern receivers and transmitters, with a brief chapter on frequency modulation. Exercises, review questions and problems facilitate its use as a text. The few errors in the book are obviously a result of the urgency under which it was prepared, and may be expected with all similar texts now coming off the press. *Fundamentals of Radio* should prove of particular reference value to teachers with an elementary physics background. —J. S.

RADIO POCKET TROUBLE SHOOTER "GADGET." Alfred A. Ghirardi. Radio & Technical Publishing Co., N. Y. Each 50c.

THE gadget consists of a set of tabbed cards, approximately 5 x 7 inches, on which common radio receiver troubles are classified and arranged in a unique arrangement that reveals the possible causes of any of the common radio receiver troubles. Two gadgets are published, one for home radios and one for auto radios. The young serviceman should find these both instructive and helpful. —J. S.

ELEMENTARY METEOROLOGY. Vernon C. Finch, et al. McGraw-Hill Book Co., N. Y., 1942. 301 pages. $1.76 list.

THOUGH prepared primarily to meet the needs of students in the preflight training programs, this text should prove of interest to the science teacher whose work touches on weather phenomena. The information is abreast with the latest meteorological developments, and its authenticity is guaranteed by the caliber of the authors. As it covers an extensive field of information, the instructor will find it necessary to suplement the text in spots. The value of this book as a text is enhanced by the summary, questions, suggested activities, topics for class reports and references at the end of each chapter. Two chapters are devoted entirely to weather applications to aviation. —J.S.

FUNDAMENTAL JOBS IN ELECTRICITY. Edgar C. Perry, Superintendent of Schools, Indiana, Pa. and Harry V. Schafebook, Stetson Junior High School, Philadelphia Pa. McGraw-Hill Book Company, New York, N. Y., 1943. 447 pages, over 400 illustrations. $2.20 list.

Designed as a practical shop text for an introductory course in electricity this book offers a wealth of practical teaching projects that give a basic understanding of electricity and its applications. It is so designed that individual students may work through the course with a minimum of attention from the instructor. There is some repetition in the principles and work covered, but probably no more than could be expected in this type of course.

The book is profusely illustrated and attractive. It is not only suited as a text but could well be used in the physics library as a source of practical projects for interested students.

REVIEW OF EDUCATIONAL RESEARCH, Vol. XII, No. 4, Oct. 1942. American Educational Research Association, a department of the National Education Association, Washington, D. C., 94 pages. Single copy, 1.00.

The October, 1942 issue of the Review of Educational Research is devoted entirely to science and mathematics and covers the educational research in this field for the period ending March, 1942. The overview is written by S. R. Powers of Teachers College, Columbia University. The teaching of the sciences in the grades and high school and in extra-school education are covered thoroughly and in concise form. The training in the grades is covered by Francis D. Curtis of the University of Michigan. The final article dealing with teacher education is written by R. Will Burnett of Stanford University.

PRE-FLIGHT TRAINING TEXTBOOK SERIES. McGraw-Hill and Company. 1943.

Just published is a series of twelve books produced under the supervision of the Training Division, Bureau of Aeronautics, United States Navy. These books include Mathematics for Pilots, Physics Manual for Pilots, Principles of Flying, Operation of Aircraft Engines, Aerology for Pilots and seven volumes on Air Navigation. Although written for the United States Navy Training Program, the books could well be used for a year course on the high school level or for a more intensified course in college.

Science Teaching for Better Living, A Philosophy or Point of View. Nathan A. Neal, James Ford Rhodes High School, sub-committee chairman. Published by the Amecican Council of Science Teachers, a department of the National Education Association, 1942. 74 pages. 35 cents, net.

The thought of the Philosophy Sub-committee, as given in this report, points the way for all other reports of the National Committee on Science Teaching.

The report first presents the situation in the world about us with which science education must deal and traces past developments in science education up to the work of the National Committee. It stresses functional science teaching and indicates the need for considering problems of every day living as well as possible teaching approaches to them. Implications of the report for future developments in science education are included.

DETERMINATION OF VITAMINS

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ture. Usually it has been necessary to visit a laboratory and see it worked out before using it successfully. Courses are being offered at several universities now which will help to train more people in the technique.

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